METALS and ALLOYS

The Engineering Magazine of the Metal Industries

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Flight of planes always suggests the release of unfettered power. No material used in aircraft construction has done more to free these essential weapons of war from hampering weight than magnesium. An equal amount of *even any comparable light structural metal* would weigh 50 per cent more! Today Dow magnesium production capacity is many times greater than pre-war facilities provided. After Victory, designers will have full access to this vast production to lighten the load of practically everything that moves.

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THE DOW CHEMICAL COMPANY, MIDLAND, MICHIGAN

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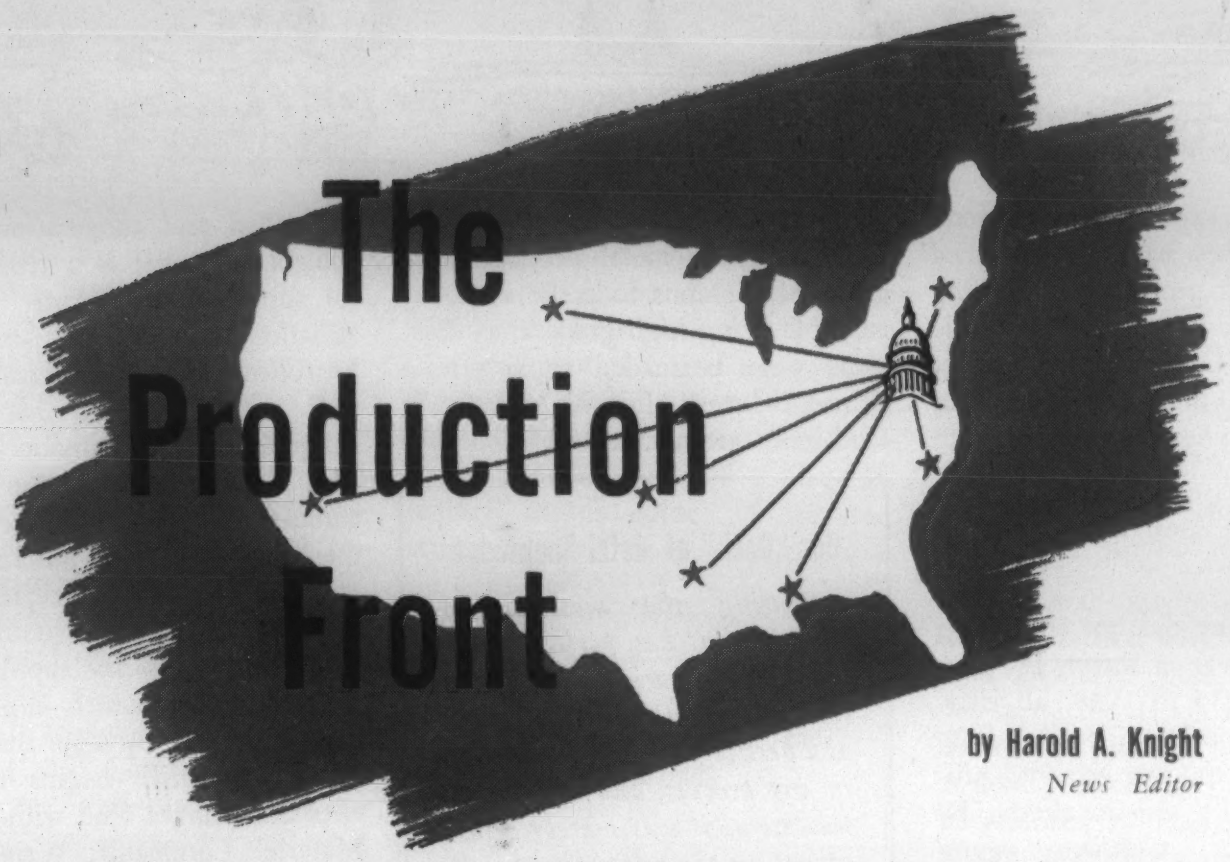


The Production Front

by Harold A. Knight
News Editor

Germans at last know war on own soil. . . . We talk of ammunition in terms of number of enemy killed. . . . Germany's mass production winds up with hand filing. . . . We make new output records in airplanes and ships. . . . Steel production reached 100 per cent. . . . Critical metals holding their own.

Consumers help by keeping inventories working. . . . Iron ore supply was stupendous "mistake" of big business. . . . We are in second phase of conversion. . . . Now we merely convert from one line of war goods to another. . . . Our production looks good in perspective. . . . Physical "tests" at Watertown—a whimsy.

Hitler and Tojo are useful men—for cartoonists! . . . There was no post-war planning in War I. . . . Boom will follow the war if we plan right. . . . Planning flow of components follows CMP idea. . . . We saw cannon cast centrifugally. . . . Green lights for more steel!

Germans Know War by Now

The reasons the Germans were willing to provoke another war is because they never suffered enough in the first war and, hence, did not appreciate the full seriousness of a major conflict. During World War I no German was hurt on his own soil, and civilians knew nothing of death and pain. Such is the theory held by many in recent years.

But it isn't that way now!

Germans who lived in Cologne, Berlin, Essen, Duisburg, Emden, Hambury and some two dozen other cities know war's realities — if they are still alive — through the block busters dropped by British Americans and Canadians. Germans who fled for their lives when two important dams in the Ruhr valley were broken by R.A.F. plane-dropped mines, causing Germany's worst war disaster, now know what war is at first hand.

Yes, the fruits of our Production Front are at last accomplishing that for which they were created. It was difficult at first for us mild-mannered, soft-hearted Americans to enthuse over blood baths. But "blood, sweat and tears" have become a reality, and we have hardened to that reality. We look upon it all as we do toward the dear one on the operating table. There must be blood and pain — then cure and sweet peace of good health again.

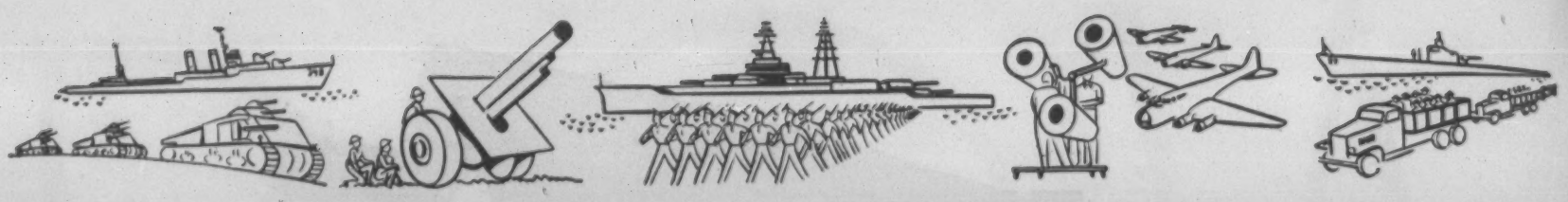
How Many Will It Kill?

Even our thought and talk have evolved towards greater grimness. At first we counted how the metal from one typewriter spool would make two firing pins for a hand grenade; how copper from one brass ash tray would make ten cartridge cases. Now we visualize each piece of equipment in terms of dead Germans or Japs, as callous as that may sound, realizing that if we don't get them, they'll get us.

Thus L. A. Umansky, Industrial Engineering Department, General Electric Co., stated in a formal speech: "Any ton of copper saved by skillful engineering does not mean merely that a few hundred dollars are saved, but that this copper can be used to manufacture some 80,000 machine gun cartridge cases. Even if only 1 per cent of these rounds of ammunition reach their goal, there will be 800 fewer enemies facing us." There's cold calculation for you!

Germany's "Mass" Production

It is comforting to learn by experience that our munitions are second to none throughout the world. Among the Axis, German equipment is best and is invariably called "good" by American ordnance men. But the Germans have not yet mastered mass production, it is evident



from latest captured equipment. Even where they have accomplished their best mass production, finishing is done by hand, as observed by file marks. The German mind cannot yet quite get the "feel" of mass production, where perhaps each workman is skilled only on some minor operation. The German conceives only the versatile skilled machinist.

That Germany did not envision a long coming war is shown by guns made from 1934 to 1938, all characterized by much skilled hand labor and many touches given to produce rather silly artistic effects. By 1940, however, Germans swung into some semblance of mass production. Fusion welding at the hands of the Germans is decidedly inferior. Shortage of copper has apparently been her worst materials handicap.

We Set Up New Output Records

United States Munitions production in April advanced 7 per cent over March, even though there was one less working day, according to the tenth of a series of monthly reports by Donald M. Nelson. All major categories of munitions were produced in larger quantity. Output was in best balance since Pearl Harbor. Aircraft embraced 83 per cent of all munitions produced, but did not quite meet the month's objective.

During the latter part of April, steel production attained 100 per cent, though there is doubt whether the nation will reach the original goal of 92,000,000 tons of ingots for the year, since new plants are not starting operations as soon as expected. Yet, never before have our steel makers worked so long a stretch at near capacity as during the past three years.

The supply of critical metals is holding its own. Every so often WPB revises and reclassifies critical materials into three classes, based on relative criticalness, but metals, in the April 22 revision, stand where they were previously, though with the comment that bismuth, cadmium and tin are relatively more tight.

Occasionally, metal producers are extremely anxious to make sales, an example being high-grade zinc. Russians were persuaded to substitute Prime Western for high-grade in lend-lease arrangements, accounting in part for this situation. Small diamond dies, 0.0015 in. and under, for wire drawing are now being produced in excess of current consumption and being stockpiled.

Much of the better materials supply is due to the Controlled Materials Plan and cooperation of consumers. Typical is a letter written to suppliers by North American Aviation, Inc., Dallas, starting out as follows: "It has become necessary to notify you that material shipped us in the amounts that exceed 10 per cent of the total accumulative monthly delivery schedules outlined on our purchase orders will no longer be accepted by us. If disregarded, this would give us more than a 60-day supply of material on hand, which might be urgently required by other manufacturers." As CMP begins operation, critical shortages filed with the AAF Material Command, Wright Field, Ohio, "have reached a new low."

Speaking about supplies of materials, our huge stock of Lake Superior iron ore (over 90,000,000 tons yearly) is fortunately due to a stupendous mistake of big business, states William C. Hotchkiss, president of Rensselaer Polytechnic Institute, in *Mining and Metallurgy*. Early in this century, owners of these deposits overestimated the growth in the use of ore (perhaps not realizing the importance of steel scrap).

Accordingly, they spent millions of dollars and many years of labor stripping these deposits of their glacial overburden. The great investment has been lying idle and useless for 30 years, eating its head off in taxes. But it has proved to have been a blessed "mistake."

Conversion Is in Three Stages

We are by no means through with "conversion." History books will classify three stages of conversion: (1) Peace-time lines of manufacture to war goods; (2) war goods of one type to war goods of another to meet shifting war strategy; and (3) conversion from war industry back to peace. In recent months we have been in the midst of the second stage, but the third is very remote, indeed, at present, if Washington big-wigs are to be believed.

Among the conversions accomplished in Class 2, as announced by WPB, have been the following: Ammunition manufacturers have

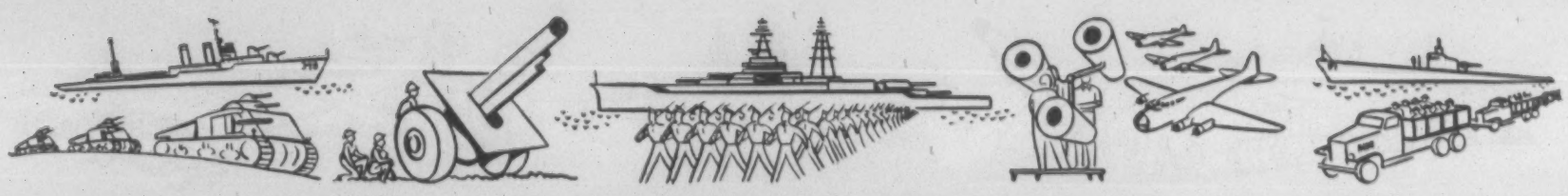
Our "Bank" of Metal Knowledge

Sharing the metallurgical "know how" has, perhaps, been the most remarkable contribution to our war effort. As soon as a pestiferous "bug" appeared in any process, alloy or special treatment, it was merely a case of get on the telephone. Somewhere in the United States was some metallurgist with specialized knowledge on that remote phase of metal-working.

Such was the gist of a statement from a man, towards whom ears of all metal engineers turn whenever he speaks — that be-medaled Dr. Zay Jeffries, technical director, Lamp Dept., General Electric Co., Nela Park, Ohio, and officer of two important war metallurgy councils.

The occasion was the New England regional meeting of the American Society for Metals at New Haven, Conn., May 22. "Industrial plants have opened up their metallurgical archives for the first time in world history," he said. "Hundreds of millions of dollars' worth of research has been made available to all United Nations' war workers for the asking.

"Our specialized knowledge was pulled out of a bank, where it had been accumulating for 150 years."



turned to aircraft engine parts and instruments; plants tooled for aircraft engine accessories are now producing small arms; gun shops are making aircraft landing gear; a tank armor plant is now producing engine cylinders, which are turned and bored on small lathes; tank fabricating facilities have been used for aircraft framework; a plant to make recoil mechanisms for cannon has been changed over to struts for aircraft landing gear.

After all, conversion makes us versatile and will give us experience for that day when swords will be redesigned, repatterned, cut and heat treated — emerging as ploughshares.

Perspective on Our Production

Lest we "fail to see the woods because of the trees," let's try to get perspective on our war production effort to date. Perhaps Harold V. Coes, president of the American Society of Mechanical Engineers, gave us this very thing when he said at the Society's spring convention: "The United States has produced in two years what it took Japan 30 years to do, Russia 20 years and Germany 10 years." Not strictly true, of course. A little man in Dearborn, Mich. who turned out a Model-T Ford, one of our fathers of mass production, knows that actually for us it has been more than two years. The fledgling bird has learned to fly through the accumulated experiences and instincts of millions of generations.

Rigorous Tests for Sight, Hearing

In the midst of grimness of modern war, a smile, a chuckle, a laugh, a guffaw — all help to relax the face and, perhaps the belly muscles. Our laugh-of-the-month was given us — of all places — in that deadly serious arsenal of the U. S. (and democracy) at Watertown, Mass. Many retired machinists were being summoned back to work. One old codger limped into the works with a cane, almost bent double with "rheumatiz" and a host of other infirmities. But he did good work with his machine tool.

A group of technical men visited the plant, identification badges on lapels. One cynic among them, noticing the old wreck of a man, remarked to his guide: "I see your workmen don't have to pass physical tests here."

The guide drew himself up to full stature and with a touch of indignation in his voice replied: "Indeed they do. For instance, they must be able to *see* a flash of lightning and *hear* the subsequent peal of thunder."

To H - - - with "Heils" and "Honorables"

by V. M. McConnell

The trick mustache
Is futile now,
And so is
Jap politeness.
No more shall packs
Of maniacs
Distort eternal rightness.

Through miracles
Of metal work
Our armaments increase.
Our metal might
Shall win this fight —
And after that,
The peace.

Advertisers View Post-War

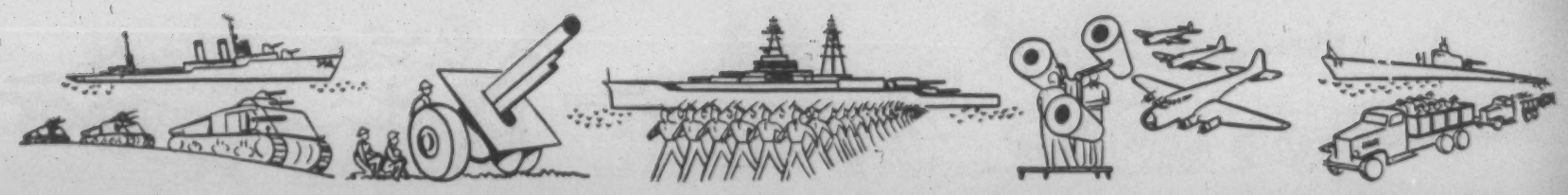
Here are some random but key statements made by formal speakers at the post-war planning meeting, Atlantic Regional Conference, National Industrial Advertisers Assn., Inc., at New York, May 7.

There was no post-war planning during the first World War because that, by comparison, was a mere interruption — not a world cataclysm. In that war only a quarter of the total production was for war — now it is one-half. This war has swept out many old landmarks of society. Tariffs will have to be reconsidered. A good share of exports will have to be financed by loans.

The War Production Board will be in the best position to supervise demobilization. We need an orderly W.P.A., and not one with the "pork barrel" tactics of 1930. When peace comes, we must avoid an "industrial Pearl Harbor" — this time we must be prepared. Right now we have the best industrial plants the world has ever known. Also the best trained men. We are a generation ahead on materials and design. We must not throw away these advantages when peace comes.

In 1918 nothing was known of market research. Now industry and Government are working together on post-war problems. The far-sighted company today is planning to hold over into peace time at least 60 per cent more working forces than in previous normal times. Shallow thinkers will lean on the Government, but the rugged individualist is even now planning post-war with a sound organization already formed for study, and perhaps in cooperation with similar companies in his field.

In post-war years competition among research departments will be as keen as among sales departments. The impact of many new raw materials will mean many new products, and there will be many new designs and finishes for old items. Western Europe will be exhausted, and the United States will take the initiative in replenishing the world. A boon for business and industry will follow the war.



Newest "Alphabet" Agency: CSP

The Components Scheduling Plan, which went into effect on June 1, is one that parallels Controlled Materials Plan. Experiences gained with CMP undoubtedly helped frame CSP and made the War Production Board enthusiastic over the scheme. Whereas CMP is designed chiefly for control of plain materials, CSP controls those materials after they have been fabricated into components or vital parts of some final assembly.

The CSP has been incubating for 18 months, the need for the plan having become evident when forging machines for diesel engine crankshafts proved a severe bottleneck. The plan is designed to give each manufacturer in the contracting chain the correct relationship in time and quantity between the requirements for components placed upon him and the program into which those components go.

It is based upon the fact that there are certain principal components around which limitation of an entire production program may revolve. CSP proposes to establish controls over these key components, thereby establishing production controls over the entire war production program.

For example, if there are only enough suitable boilers available, on the basis of production capacity, to build 100 ships, it would be foolish for the Navy to schedule more than 100 ships for construction. However, boilers might not be the limiting factor in ship production. A sub-component of a boiler might be the limiting factor. The plan is flexible enough to include sub-components.

Ten Agencies Are Involved

Claimant agencies included under the plan are: Army, Navy, Maritime, Aircraft Scheduling Unit, Rubber Director, Lend-Lease, Bureau of Economic Warfare, Petroleum Administration, Office of War Utilities, and the Canadian Division of WPB.

Major programs involved are: ships (all sizes and types), tanks, combat vehicles, motor transport vehicles, power generating plants, and plants for production of rubber, high octane gasoline, aluminum, magnesium, and steel.

Control components included are: Turbines, turbo generators, motor generator sets, internal combustion engines, boilers, compressors, dry vacuum pumps, turbo blowers and exhausters, steam condensers, heat exchangers, pressure vessels, fans and blowers, switch gears, pumps, stokers, pulverizers, and transformers.

The above items are control components when, and only when, they are purchased directly from the manufacturer by the prime contractor of claimant agency that is building the product or project into which the component will go. When purchased by others, these items are sub-components.

Sub-components, as well as including the above items when purchased by persons other than prime contractors and claimant agencies, include: Crankshafts, fuel injectors, carburetors, magnetos, reduction gears, electric motors, electric motor controls, and generators. These are sub-components regardless of who purchases them.

The distinction between control components and sub-components can be illustrated in the following manner: A prime contractor working on a Navy ship places an order for a power boiler, complete with stoker, force draft fan, and feed water pump. Each of these last items will be equipped with electric motors and electric motor controls.

Here, the boiler is the control component. The stoker, fan, pump, electric motors and electric motor controls are sub-components, if purchased by the boiler manufacturer. However, if the electric motors and motor controls were purchased for installation in a boiler that was already in place, the motor would be the control component while the motor controls would be the sub-component.

We Visit Watertown Arsenal

We visited the arsenal at Watertown, Mass., one of the six old time manufacturing arsenals. These six were not calculated to carry more than 5 per cent of the war load, but have accomplished considerably more. At Watertown, the original building of 1816 is still gainfully occupied.

We were the first outsiders, save for British metallurgists, to see guns cast centrifugally — from 37 to 105 mm. Steel bars, melted in an electric induction furnace, are ladled into the centrifugal machine with its cast iron chill mold, whirled horizontally emerging red hot as a cannon in 15 minutes, and containing a small hole in the center, which is the section containing slag and impurities.

Six guns at a time are craned to the quenching tanks, where geysers of steam rise, thence to the heat treat furnaces. The cannon are equal or better than forged guns, and are made with much more speed and at lower cost. The arsenal has experimented with centrifugally-cast guns for 15 years, but only during the last two have they really produced.

Watertown specializes in gun carriages, though it makes cannon in the rough, turned and heat treated, which are rifled at Watervliet.

In the laboratories were the 1,000,000-volt X-ray, the polariscope, the many mechanical properties testing machines, including the famous 1,000,000-lb. Emery, installed in 1879; the chemical laboratories and the new electrical gadgets in the field of electronics.

Green Lights for More Steel!

Just before the printer closes up these forms we learn that steel is once more far in the lead as a critical material. For the third quarter a million tons deficit is seen. Heaven and earth are being moved to get this. "Green lights" have been switched on to rush to completion seven open-hearth and electric furnace projects, whereby the owners of these in-process furnaces will get needed components so as to be able to start steel production.

Arms and the Casting

Those foundrymen and others who attended the recent annual meeting of the A.F.A. in St. Louis heard and saw much evidence of the vital and integral place castings now occupy in our overall armament program. Of course all the divisions were concerned with technical papers and problems directly related to the war effort — some perhaps more spectacularly than others — but beyond this was the proud awareness that castings *of all types* are being specified for and performing in military and naval components in a way that was considered impossible in World War I.

The record shows that the consumption of steel castings in ordnance (including tanks) has risen by some 500 per cent in the last two years. But even more remarkable is the expansion in the use of gray iron castings; although some individual foundries have been pinched in their gray iron output, the industry as a whole has expanded its iron-casting operations, and the statement was authoritatively made that in 1942 the consumption of cast iron in ordnance was 6 times that of steel castings. And graphic testimony to the skyrocketing use of aluminum and magnesium castings was provided by the room-filling attendance at the meetings and luncheon of the Light Metals Division.

Forty-thousand pound iron is no longer the exception and heat-treated steel castings are doing jobs formerly the exclusive province of forgings or steel plate. The current acceptance of castings, and particularly gray iron castings, for such applications is the direct result of both improved technology and sound, aggressive education of engineers to the real engineering qualities of cast materials vis-a-vis wrought.

The war has impelled the development or expansion of several new materials that are expected to present a powerful challenge to the older metals, alloys and forms for peace-time markets. But it has also been responsible for some tremendous improvements in the quality of many old standbys, and engineers will do well to watch *both* trends for their post-war significance. —F. P. P.

Post-War Aluminum

A problem, uppermost in the minds of very many persons, both industrialists and laymen, is the status of several of the metal industries after the close of the war. In many cases the supply, due to expanded plant facilities and production, already far exceeds that of the pre-war period. Prominent among these are the aluminum, magnesium, copper and steel industries.

Take the case of aluminum — capacity for making this metal is estimated at 1,050,000 net tons per

Machine Output
UP 37% TO 110%
with INLAND LEDLOY

LEDLOY is the lead-bearing, faster-machining steel that produces more parts per hour, lowers labor and machine costs, and increases tool life up to 300%.

Inland Ledloy is open hearth steel containing a small percentage of lead added by a special Inland process. This addition of lead results in slight refinement of grain structure and greatly increased machinability. In all other physical properties—yield strength, ultimate strength, elongation, reduction of area, etc.—Inland Ledloy is the same as open hearth steel of similar analysis.

Today, Inland's entire production is being used by war industries to help win the fight for freedom, but when peace comes Ledloy will again be available for general manufacturing use.

Write for further information on Inland Ledloy

"Foreign Agent"—LEDLOY LIMITED
66 Cannon Street, LONDON

Reports on five Inland Ledloy case studies recently made in British munition plants:

No. 1—Bottom Bracket Cycle Spindle

	Free Cutting Steel	Inland Ledloy
Spindle speed	500 r.p.m.	700 r.p.m.
Time per piece	59 sec.	28 sec.
Tool steel	18% tungsten	18% tungsten
Increased production	—	110%

No. 2—Grease Nipple

	Free Cutting Steel	Inland Ledloy
Spindle speed	2,495 r.p.m.	4,140 r.p.m.
Time per piece	20 sec.	13 sec.
Increased production	—	53%
Increased tool life	—	300%

No. 3—Set Screw

	Screw Stock	Inland Ledloy
Spindle speed	490 r.p.m.	693 r.p.m.
Time per piece	95 sec.	69 sec.
Increased production	—	37.6%

No. 4—5/16" x 2" Bolt

	Screw Stock	Inland Ledloy
Spindle speed, turning	896 r.p.m.	1,126 r.p.m.
Spindle speed, threading	296 r.p.m.	373 r.p.m.
Time per piece	21 sec.	13 sec.
Increased production	—	62%
Increased tool life	—	300%

No. 5—Locknut Blanks

	Free Cutting Steel	Inland Ledloy
Spindle speed	2,140 r.p.m.	2,140 r.p.m.
Time per piece	18 sec.	10 sec.
Increased production	—	44%
Increased tool life	—	50%
Spindle speed, tapping	950 r.p.m.	2,200 r.p.m.
Increased life of tapping tool	—	200%

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year at the end of this year — many, many times the supply before the war. A similar situation prevails in other industries, particularly in magnesium. The problem confronting the leaders in the aluminum industry — and economists also — is how can the expanded supply of this metal be employed when peace comes.

These factors will exercise a decided influence in shaping the future uses of aluminum. According to a statement entitled — "Background Data on Post-War Planning Activities of the Aluminum Co. of America" — recently made public, these three factors are: Price, quantity available, and the increased number of workers possessing the know-how for fabricating and handling aluminum.

As to price, a most important factor, the trend is downward — since 1939 the quotation per pound has declined 25 per cent. "With the basic price policy of Alcoa downward, lower prices may be anticipated."

As to quantity available — with the capacity expanded to its present proportions, there will definitely be an adequate supply for any civilian developments.

As to the third factor — it must be conceded that more workers are familiar with the properties and adaptability of aluminum, the "know-how of its fabrication and handling," than ever before. Hence the supply and facilities and particularly the labor schooled in its manipulation will be a potent factor in promoting a demand for the metal and its adaptability to new uses. A similar situation exists in magnesium.

In the statement referred to, the Aluminum company offers the following interesting estimated analyses of the uses of aluminum before, during and after the war, which tell their own significant story:

Market	Nov. 1939 Per Cent	Dec. 1940 Per Cent	May 1942 Per Cent	After World War II Per Cent
Transportation (Land, air and water)	29	10	63	34
Cooking utensils	14	6	1	10
Electrical conductors	10	5	0	8
Machinery and electrical appliances	15	9	6	12
Building construction	8	5	3	9
Chemical	5	5	5	5
Foundry and metal working	4	23	19	9
Ferrous and nonferrous metallurgy	5	4	2	4
Food and beverage	6	2	0	5
General miscellaneous	4	1	1	4

Industrialists are not asleep as to post-war problems. Many large and small companies are giving serious consideration to the status of their industries in the post-war period. They are not only making plans for the future but are constantly being approached by others interested in their products and its possibilities in solving certain problems.

The situation as to aluminum in the post-war period, while serious, it not without its hopeful outlook. The more thought devoted to post-war problems from now on, the better for all concerned.

—E. F. C.

Women in Post-War Industry

Perhaps one of the most surprising phases of our war industry has been the efficiency of women workers, of particular surprise in the heavy products plants. Recently Ralph Kelly, president of the Baldwin Locomotive Co., remarked: "Women are in our heavy work shops to stay — even when peace comes." We recently visited the arsenal at Watertown, Mass. where, of the 9,000 employees, one-third are women who run heavy cranes and all types of machine tools — and this arsenal specializes in heavy work — and they even work on the melting platform in the foundry.

To some extent machines and equipment have been remodeled slightly to permit women to operate them, bringing in the element brain, instead of brawn. Of course the evolution of machinery was in this direction even previously.

But what will happen to the women industrial workers when the men come back from the wars? Undoubtedly a large proportion will voluntarily go back to their homes, for husbands and sons will be there and wanting their attention. Yet perhaps a quarter of them will want to stay.

In such cases there will probably be a survival of the fittest, assuming that labor unions do not impose artificial restrictions. Probably women will survive on the jobs requiring dexterity of hand, brain and eye, such as sorting and inspection. Men will be supreme where brawn, endurance and danger prevail as well as in the more highly managerial positions.

The two sexes will continue to work in harmony and the novelty phases will have worn off. After

(Editorials continued on page 1208)

Refrigerating Aluminum Alloy Rivets and Parts

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No. 1 in a series on Refrigeration in the Metal Industries

In view of the fast-growing interest in the use of cold treatment in metal-processing, it is timely indeed to have this engineering discussion of one of its most important phases — the use of refrigeration to retard the age-hardening of aluminum alloy rivets and parts. An outstanding feature of this article is the detailed information it presents on the actual retarding effects of various temperatures on the aging of different alloys. —The Editors

COLD-TREATING OF METALS finds wide application in aircraft plants where aluminum alloy rivets and sheets are cooled below 32 deg. F., immediately after quenching, in order to delay normal age hardening. Certain strong aluminum alloys increase in strength and hardness through aging at room temperature after quenching. These maximum properties, so desirable in the finished product, are gained at the expense of workability, so it is often desirable to perform riveting or forming operations in the "as quenched" condition before this natural aging takes place.

Refrigeration, which retards age hardening, is used in two stages: First, to reduce the temperature of the "as quenched" metal rapidly; second, to store material until production schedules permit forming. Contrary to public belief, refrigeration is not used to shrink rivets to provide tighter fits but solely to delay age hardening.

Techniques used in cold-treating metals have been adapted from cold storage and quick freezing of foods. Mechanical refrigeration is employed direct or through the medium of dry ice. Metals refrigeration has uses other than delaying age hardening of aluminum alloys, such as shrinking steel parts, stabilizing steel in gages and for precision machining and cooling spot welding electrodes to reduce "pick up." This article, however, will be confined to the use of refrigeration as an aid in fabricating aluminum alloys by maintaining "as quenched" workability for several hours or even days.

The Alloys and Their Heat Treatment

Three aluminum alloys of the natural aging type are used for most aircraft rivets. Nearly half of these are alloy A17S (Cu 2.5%, Mg 0.3%, balance Al). Where higher strength is desired 17S (Cu 4.0%, Mn 0.5%, Mg 0.5%, balance Al) is more commonly used. A small, but increasing, proportion of rivets of the highest strength alloy 24S (Cu 4.5%, Mg 1.5%, Mn 0.6%, balance Al) is used. The choice between these alloys is based on strength requirements and on fabricating facilities and procedure.

Heat treatment consists of heating to 930 to 950 deg. F., for A17S and 17S alloys and to 910 to 930 deg. F., for 24S alloy. This is followed by quenching in cold water to give required strength and resistance to corrosion. In this "as quenched" condition the rivets have good workability and moderate strength. If the rivets are left at room temperature, say 70 deg. F., after quenching they undergo a change, "natural aging," which further increases strength but decreases workability. For 17S and 24S this aging is rapid for the first few hours and is virtually complete after 4 days. A marked decrease in workability is noted within an hour after quenching.

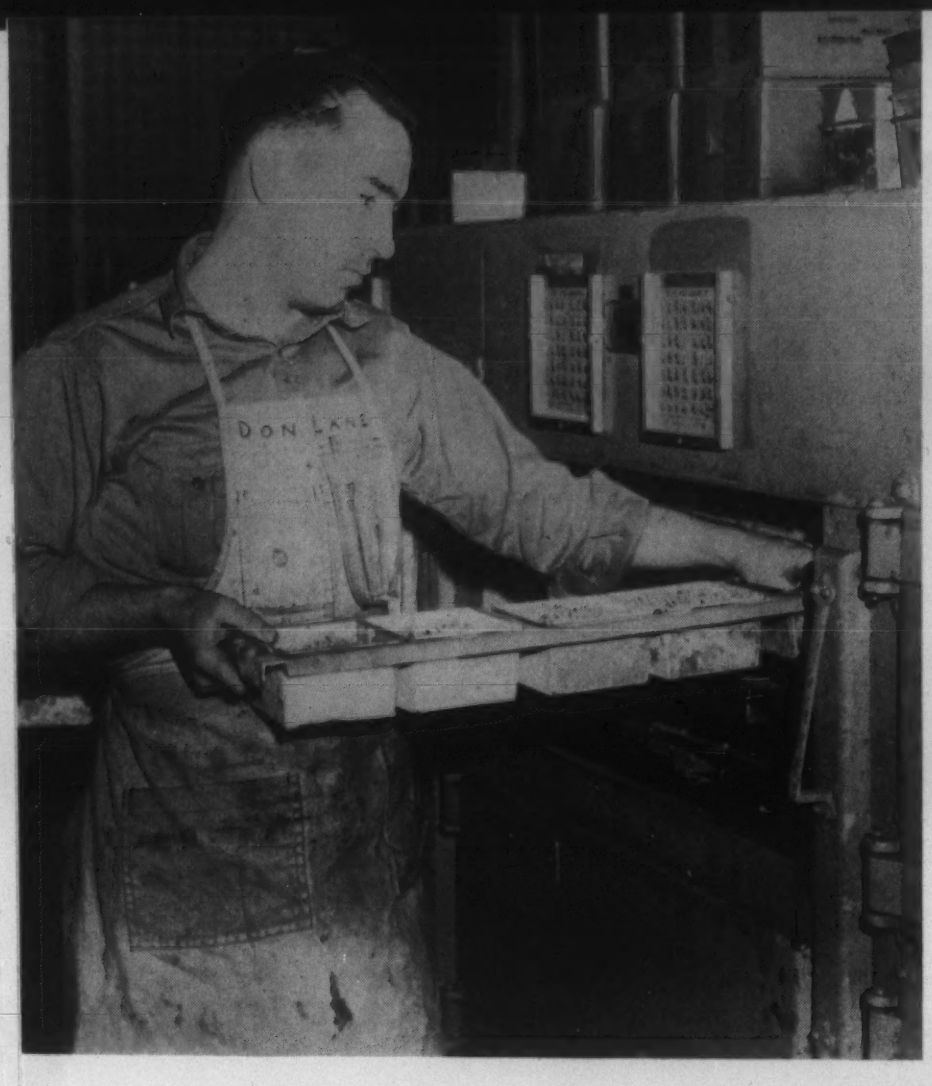
Fully heat treated and aged A17S-T rivets can be driven easily and without danger of cracking so that refrigeration of this alloy is seldom, if ever, necessary. Practically all A17S-T rivets are heat treated and aged by the rivet manufacturer and are driven "as received" by the fabricator. When so driven, these rivets have an average shear strength of 33,000 lbs. per sq. in.

Need for Refrigeration

Where higher strengths are required, 17S-T and 24S-T rivets are used. Completely heat treated and aged, such rivets are so hard that there is danger

Heat-treated aluminum rivets are quenched in cold water. (From Alcoa movie, "How to Rivet Aluminum")

Quenched aluminum rivets are immediately placed in a portable container refrigerated by dry ice. (From Alcoa movie, "How to Rivet Aluminum")



Huge refrigerators at Douglas Aircraft plant keep heat-treated aluminum rivets cold and soft for easy driving. (An Acme photo.)

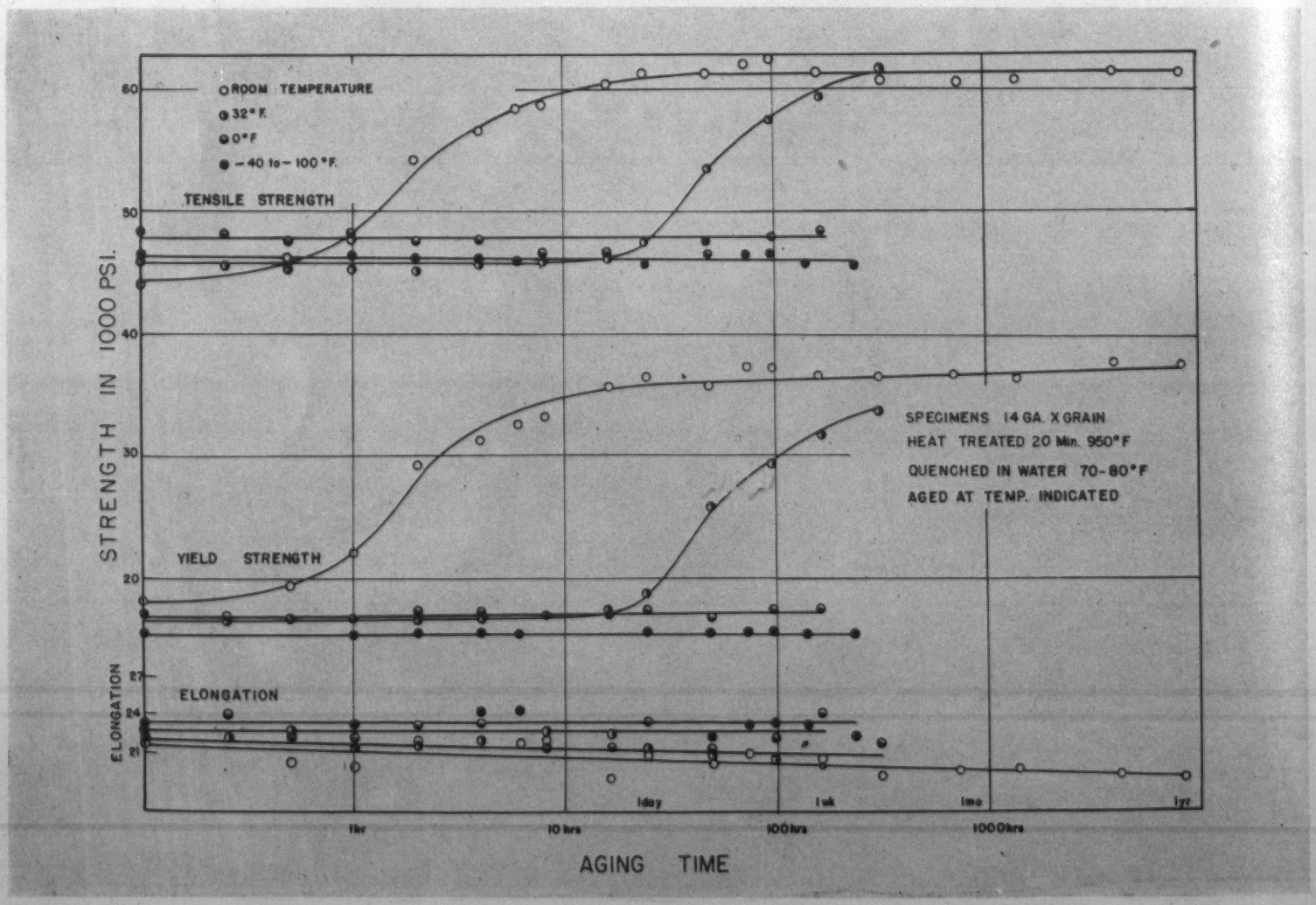
of cracking during driving. If these rivets can be driven in the "as quenched" condition, before natural aging takes place, speed of driving is increased and danger of cracking is practically eliminated. After driving, natural aging proceeds giving average ultimate shear strengths of 34,000 lbs. per sq. in. for 17S-T and 42,000 lbs. per sq. in. for 24S-T.

In large plants, riveting operations may be proceeding simultaneously at hundreds of locations scattered over a large area. By heat treating and quenching rivets in large batches at a central location, costs are reduced and control improved. Through refrigeration, "as quenched" workability is retained while rivets are distributed and stored pending their use.

To assure maximum workability rivets must be cooled rapidly and must be stored continuously at low temperatures. If at any time after quenching, the metal approaches room temperature, aging will proceed at once. Subsequent refrigeration will check this aging but will not restore the workability of the "as quenched" material.

Low temperatures are secured and maintained by mechanical refrigeration in individual units or through the medium of dry ice. Many fabricators promote rapid cooling by using refrigerated quenching water followed by immersion in refrigerated alcohol which removes moisture that would cause

Natural aging of 17S at various temperatures.



a batch of rivets to freeze together (like a pasteboard box of quick frozen peas), thus making them difficult to handle.

For distribution throughout a plant, rivets are placed in portable containers refrigerated by mechanical units or, more often, by dry ice. At the riveting station, storage is usually in special freezing units. Ingenious equipment has been developed for segregating and delivering required quantities, sizes and types of rivets to the operators.

In the early days of rivet refrigeration, dry ice, or even natural ice, was commonly used. Individual mechanical units have become more popular as their design has been adapted to this service and rapidity of cooling has been increased. Dry ice is still popular because of the low temperature it provides, because of its portability and because of the simplicity and variety of the containers in which it can be used.

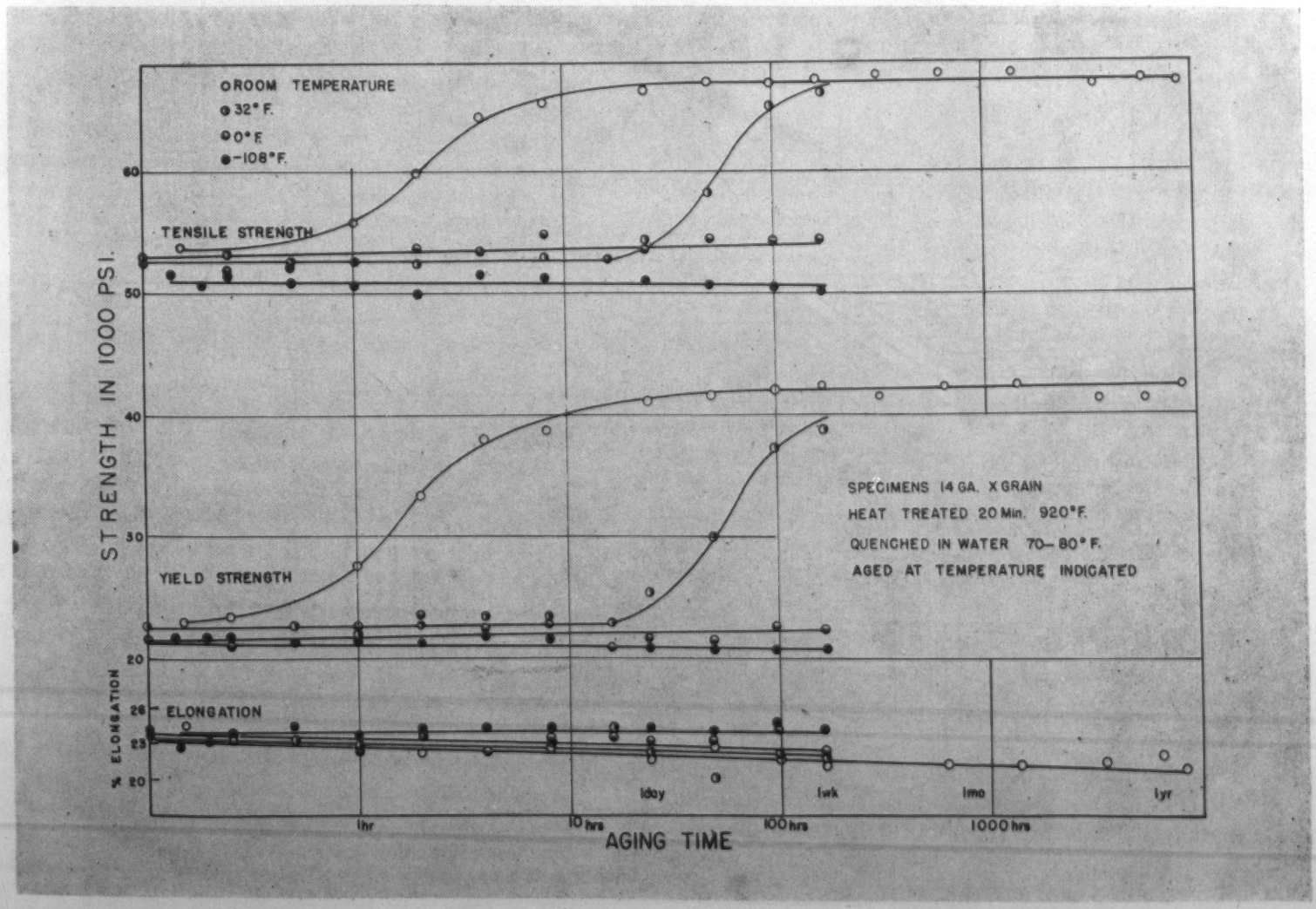
An erroneous conception, that aluminum rivets are refrigerated to give a shrink fit in the hole, has become widespread. It is true that aluminum, like other common metals, contracts on cooling, but in practice the small rivets have usually warmed up considerably by the time they have been taken from the refrigerator and inserted in the hole. Practical hole and rivet tolerances are such that the remaining expansion would not assure uniformly tight fits. At the end of the driving operation rivet and metal are at the same temperature. Tight fit is assured by the swelling of the rivet shank under the pressure of driving and a well driven aluminum rivet will produce a tight joint whether it is at the refrigeration temperature or at room temperature before driving.

An increasing number of plants are using refrigeration to facilitate the fabrication of sheet metal parts from aluminum alloys. The theory is the same as for rivets. Severe forming operations can be performed on the "as quenched" material, whereas breakage would occur if the sheet were allowed to age at room temperature before forming. Sheet may be heat treated, quenched and stored immediately in refrigerated rooms, thereby assuring good workability when operating schedules permit forming. Many sheet metal parts are partially formed in the annealed condition before heat treatment. The heating and quenching usually distorts the part but it may be refrigerated until it is convenient to restrike it in the press to bring it to its final shape with the required dimensional accuracy.

How Various Temperatures Retard Aging

The accompanying charts show the effect of refrigeration in retarding the natural aging of 17S and 24S alloys as determined by experiments conducted

Natural aging of 24S at various temperatures.



by the Aluminum Research Laboratories. Their investigations show that the behavior of both alloys is similar. Room temperature aging is virtually complete after 4 days with very little change between 3 and 4 days. If a temperature of 32 deg. F., is attained immediately after quenching and constantly maintained no aging takes place for 16 hrs. Then aging proceeds slowly, requiring about two weeks for completion. For a temperature of 0 deg. F., there is no apparent aging for a period of one week. Where dry ice is used, and a retarding temperature of —108 deg. F. is maintained, no aging takes place for a period of one week as shown by the tests and in all probability no aging would take place at this temperature over an extended period.

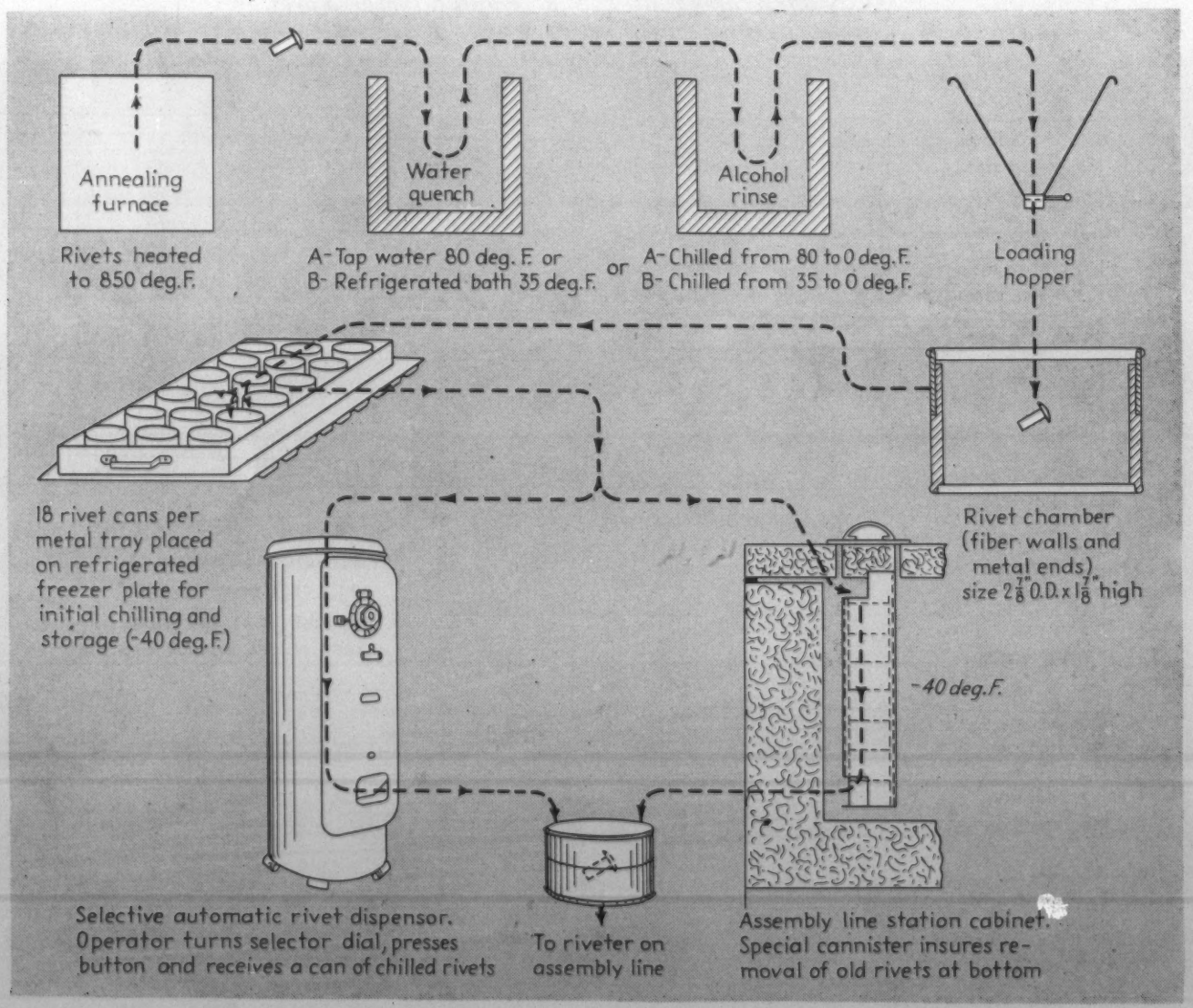
The principal difference between 17S and 24S is that the mechanical properties of the latter are higher immediately after quenching and on throughout the aging cycle; 24S does not age more rapidly than 17S but its workability is less for any given period of aging at room temperature, therefore, the value of prompt and complete refrigeration is somewhat more apparent in the case of 24S.

With either alloy, aging starts immediately on quenching and is not retarded until the material is lowered to a temperature of about 32 deg. F. If material is removed from the refrigerator, aging takes up where it left off, as soon as room temperature is approached. Further refrigeration will not cause the workability to revert to the original "as quenched" condition.

These established facts corroborate the observation by fabricators that a prompt reduction in temperature and a continuously low storage temperature are essential to obtain maximum workability. Hence the value of refrigerated quenching and "quick freezing" methods. During the handling of material some heat is absorbed from the room, so operating temperatures should be lower than those theoretically required, thus providing a cushion against accidental warming as well as a safeguard against variations in temperature control. Many fabricators find that a storage temperature of 0 deg. F., is satisfactory while others prefer to reduce this to —30, or —40 deg. F., to take care of their particular operating conditions.

Finally, let it be made clear, that refrigeration of aluminum alloys is a valuable aid to fabrication because it prolongs the period of maximum workability, thus reducing time and expense for forming and making possible the production of the intricate parts required for modern aircraft. Refrigeration does not change the final strength or other characteristics of the metal; it merely provides a period of "suspended animation." Then, when refrigeration ceases, the metal goes on to age normally to full strength.

Flow chart for aircraft rivet chilling and storage.



The Micro-Hardness Tester

—A New Tool in Powder Metallurgy

By ROBERT STEINITZ

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Quality control of the production of many metal products is exercised through hardness testing. With powder metallurgy parts however, conventional hardness testing has been generally unsatisfactory because of the porosity or the duplex structure of the material. The tester described in this article overcomes these obstacles, and appears to be the answer to many hardness-testing problems not only in powder metallurgy but also in other fields where the hardness of localized microscopic areas must be determined.

—The Editors

THE EVER INCREASING USE of metal powders as engineering materials has furthered the development of a number of specialized instruments. Some of these instruments are for determining important properties of the powders in much the same manner as conventional metallurgical tests are made on cast or wrought materials. If the hardness values of individual particles of a metallic powder or of the compact are known, the degree of strain hardening or correctness of an annealing cycle can be ascertained.

The "micro-hardness tester" is the device used for checking the hardness of the particles in a compact. Because the conventional instruments like the Rockwell hardness tester give an average reading (due to alternate metallic particles and voids in a compact) rather than particle-hardness, and, also, because the microscopic examination of polished and etched metal powders fails often to disclose differences and characteristics important to the proper control of pressing and sintering operations, the development of the micro-hardness tester is very important to the advancement of the art of powder metallurgy.

The New Hardness Tester Described

A number of these specialized hardness testers have been developed during the past few years. However, one marketed by the Eberbach & Son Co., of Ann Arbor, Mich., has filled the need for this type of instrument nicely. Essentially this instrument consists of a diamond penetrator (like that used in the well-known Vickers hardness tester) mounted so that it can be attached to a microscope in place of the objective lens. The type of microscope employed has cross hairs in the eyepiece, and by properly aligning the diamond, it can be made to touch the sample under investigation directly in line with the cross hairs. Thus, it is only necessary to adjust the microscope so that the intersection of the cross hairs falls over a selected particle of metal powder in a sample. Then the diamond can be made to penetrate this predetermined particle. By this method, the actual hardness of individual particles can be determined.

The force necessary to force the diamond penetrator into the grain of powder is furnished by a carefully calibrated spring. In operation, the diamond is lowered onto the sample to be checked by use of the fine adjusting screw on the microscope. The force exerted by the particle of metal in opposing the downward motion (and penetration) of the diamond, as the whole microscope barrel is lowered, soon becomes sufficient to overcome the influence of this calibrated spring and opens two closed contacts, thereby illuminating a small lamp.

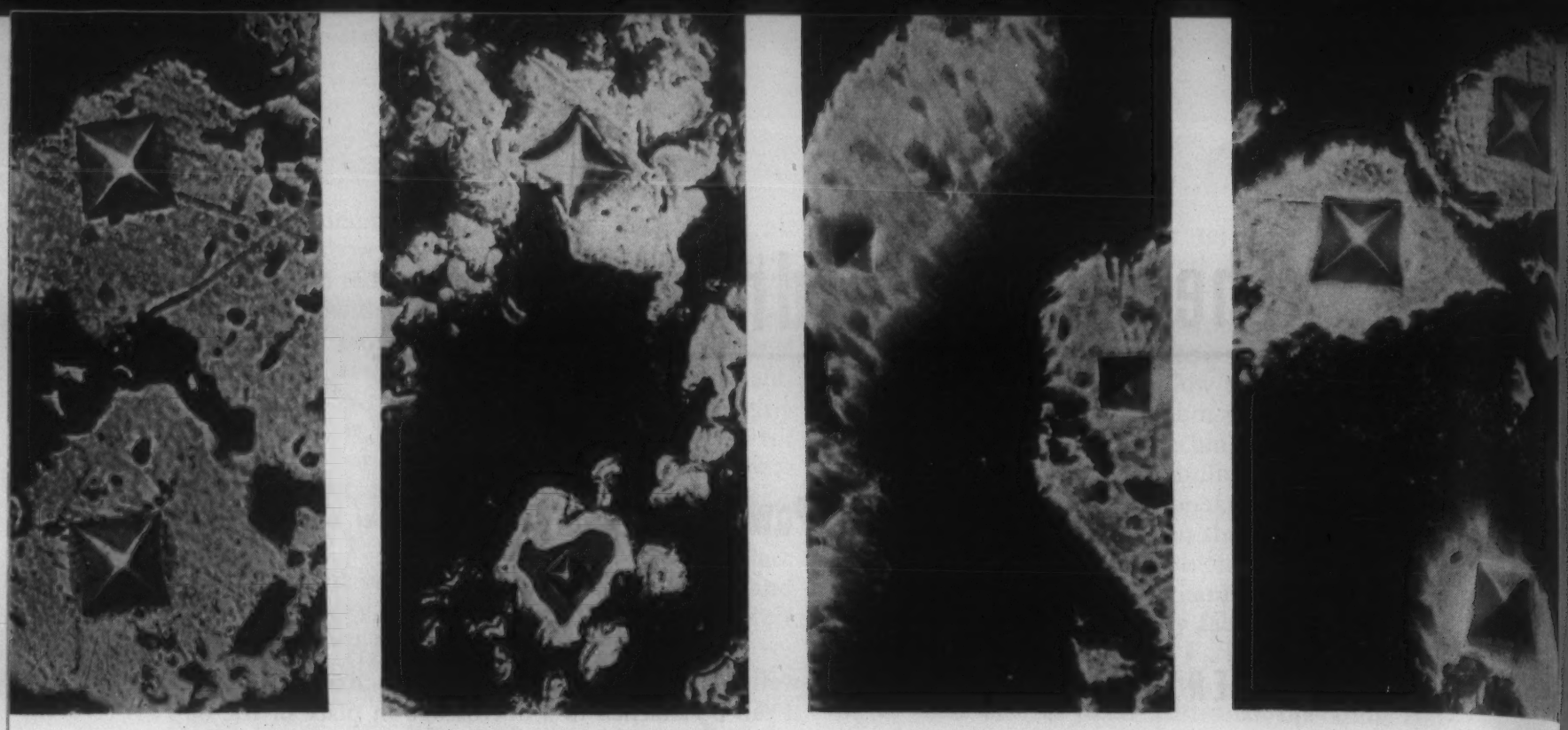
When this occurs, it signifies that the force opposing the penetration of the diamond has just exceeded that exerted by the spring. This insures that the same loading, or force on the diamond, is used on any number of separate trials (or as long as the same spring is used). Of course, springs exerting different forces can be used for the same reasons that various loads are used with standard Rockwell machines.

The diamond penetrator is accurately ground to a square pyramid shape. When an indentation is made with this type of penetrator, the diagonals of the recess can be measured by using a microscope with a micrometer eyepiece (similar to a Brinell microscope), or by making a photomicrograph and measuring the diagonals from the plate. The resulting micro-hardness number is computed in the same manner as with the conventional Vickers machine:

$$MH = 1.854\frac{P}{d^2},$$

where MH stands for micro-hardness number, P is the load tending to force the diamond into the sample expressed in kilograms; and d is the length of the diagonals measured in millimeters.

The accuracy of this method of hardness determination depends entirely on the precision with



Figs. 1 to 4 (left to right). Fig. 1 is sponge iron powder; Fig. 2 is sponge iron powder with oxide inclusion; Fig. 3 is electrolytic iron powder before annealing; and Fig. 4 is the same as Fig. 3 after annealing. All were subjected to 28-gram pressure and each one photographed at 470X.

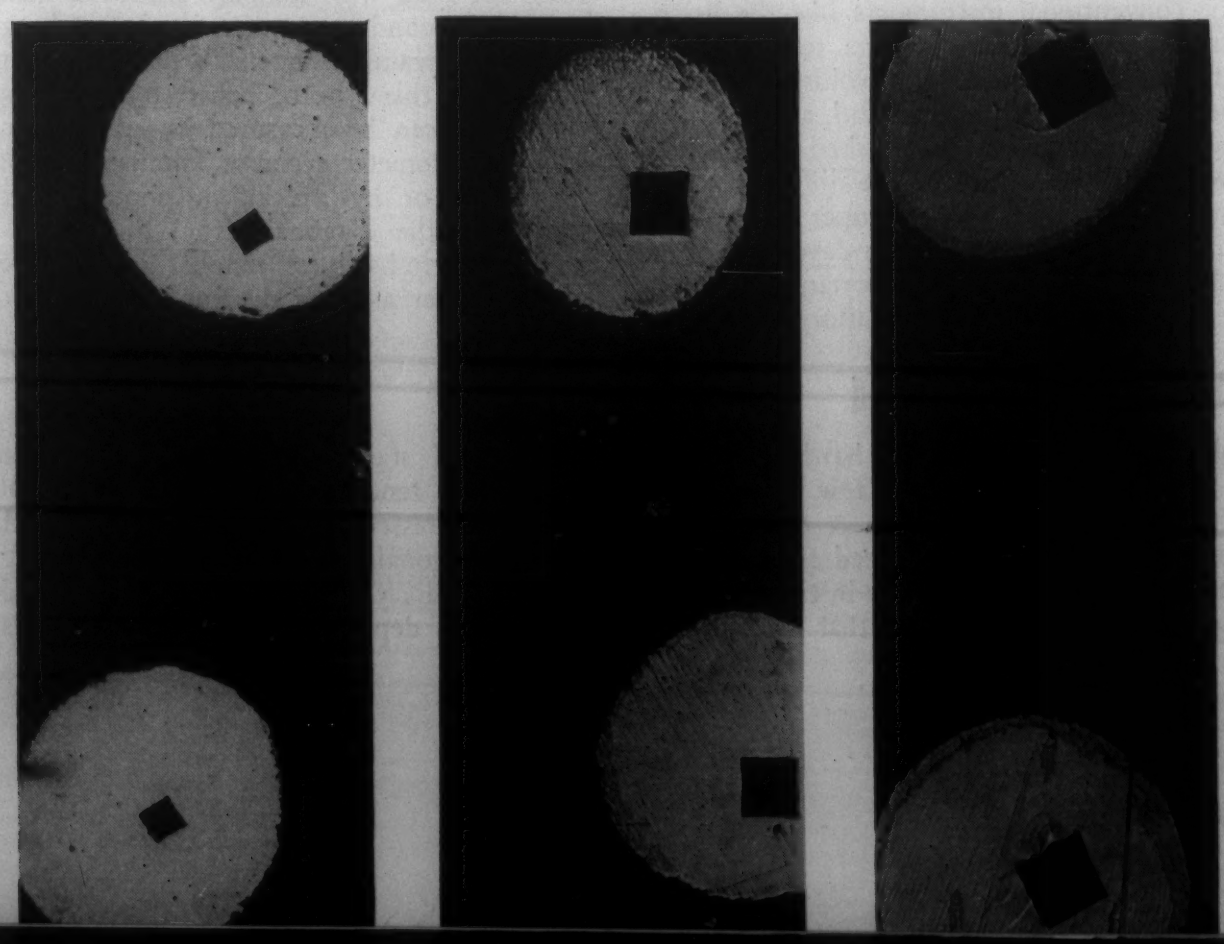
which the diagonals of the impression can be measured. If the plane of the polished specimen is not exactly horizontal, the impression will be "kite-shaped." In such a case, it has been found better to use the shorter diagonal when computing the micro-hardness number. To prevent sliding under the influence of the indenting force, the hardness-tester-microscope must have a good stage and the sample must be very firmly clamped in position. Up to a certain limit, the accuracy of measuring the diagonals can be increased by using high magnifications.

In the operation of the micro-hardness tester it is also advisable to use as large an indenting force as is possible, thereby obtaining a large and easily measurable recess in the sample. Of course, the size of the metallic particles under consideration limit the load that can be applied.

The calibration of the load forcing the diamond into the samples is easily accomplished as it depends entirely on the spring used. A set of springs giving a range of 25 to 300 grams is supplied with each instrument. These springs furnish a reasonably accurate indenting load and only when extreme precision is desired is it necessary to check them frequently.

As hardness generally is defined as the resistance to penetration, it would seem then that the hardness values obtained would be independent of the indenting force. Hanemann[1] and collaborators have investigated the relationship of indenting force to micro hardness number, and found that the hardness number is not constant if the load is changed. For practical purposes of powder metallurgy technic, however, hardness may be regarded as a constant quantity. Nevertheless, to avoid confusion it is advisable to use the same spring (and to indicate the force used) when comparing different materials and heat treatments.

Figs. 5, 6 and 7 (left to right). Decarburization of steel powder. Each subjected to 275-gram pressure and photographed at 200X.



Some Practical Applications: Iron Powder

In the following paragraphs, some practical applications of the micro-hardness tester are given. In all cases, the hardness number is given in units (actually kg. per sq. mm.) that agree with the Vickers (or Diamond Pyramid) hardness numbers as reported by Scott and Gray[2]. Incidentally, up to about 400, the Vickers and micro-hardness numbers coincide with the BHN; above this, the Brinell values are progressively smaller than the corresponding micro-hardness numbers.

In obtaining the photomicrographs accompanying each of the following descriptions, the specimens were mounted in Bakelite, and if a homogeneous material, they were not etched. Composite materials were etched to promote the distinguishing of the constituents.

In Figs. 1 to 4 are shown photomicrographs of two types of iron powder at a magnification of 470 X. In measuring the hardness of each of these samples, an indenting force of 28 grams was used. The particles shown in Figs. 1 and 2 are two samples of sponge iron from different manufacturers. The indentations of the micro-hardness tester are clearly visible in each photograph. The micro-hardness readings of sample in Fig. 1 are 49 and 47.

In Fig. 2 the oxide inclusion in the lower particle (due to incomplete reduction of the material) has a very high hardness, MH = 348, while the completely reduced particle in the upper portion of the photograph has a micro-hardness number of 60. In this photomicrograph the relative size of the two indentations is easily discernible. This illustrates one of the valuable features of the micro-hardness tester—the hardness of different areas of one particle of iron powder can be checked quite accurately.

Some samples of electrolytic iron powder are illustrated in Figs. 3 and 4. Fig. 3 shows the powder before annealing (MH = 147 and 232) and after (MH = 56, 59 and 52). The annealing not only does much to equalize the variations in hardness, but it reduces it to the same value as shown by the annealed sponge iron sample in Fig. 1.

The effects of a decarburizing atmosphere on steel powders are shown in Figs. 5 to 7. In these photographs, the samples were not etched. As these were fairly large particles, a relatively high indenting force (275 gram-weight, giving large impressions) was used. The material as quenched (MH = 750) is shown in Fig. 5; little or no decarburization is visible. In the following two pictures (Figs. 6 and 7) the effects of heating in a decarburizing atmosphere are progressively more apparent; the hardness dropping to MH = 260 and 168 respectively.

The next two pictures, Figs. 8 and 9, indicate the extreme range of this instrument. The material is tungsten-carbide and the load on the diamond was 28 gram-weight. These photographs are at different magnifications; the hardness readings average 1850. The image of the cross hairs appears in Fig. 9. We believe this to be the first time that a hardness measurement was made directly on a tungsten carbide particle and not on the cemented material.

Fig. 8. Tungsten carbide powder, subjected to 28 gram-weight pressure and photographed at 760X.

Fig. 9. Tungsten carbide powder, subjected to 28 gram-weight pressure and photographed at 1900X.

Testing Compacts

Some iron powders were pressed into compacts with a pressure of 10 to 55 tons per sq. in. and sintered at 2150 deg. F. (1180 deg. C.). The hardness of these compacts as measured on the Rockwell F scale (60 kg., 1/16 in. diam. ball) and the micro-

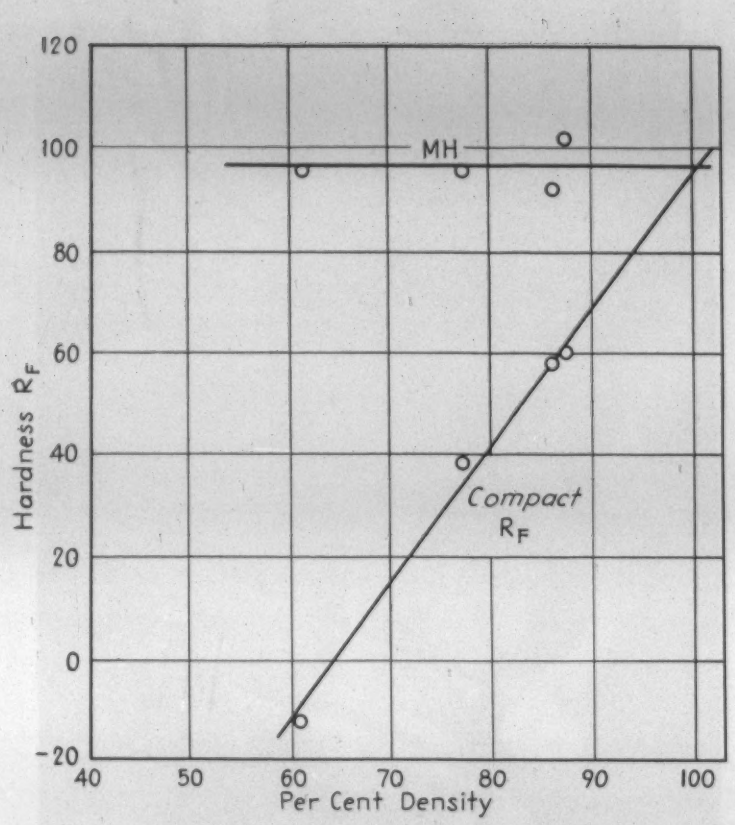


Fig. 10. Hardness versus density.

hardness tester formed an interesting comparison. Because of the porosity of the compact, the Rockwell hardness values varied while the micro-hardness number (measuring only solid particles of the compact) is constant. The following table summarizes the results of a series of these tests on this type of specimen:

Sample	Pressing Pressure, tons per sq. in.	Density		Rockwell F	Micro-Hardness	Micro-Hardness converted to Rockwell F
		g per cc.	%			
A	10	4.8	61	—12	118	95
B	25	6.0	77	38	118	95
C	40	6.8	86	58	108	92
D	55	6.9	87	60	150	102

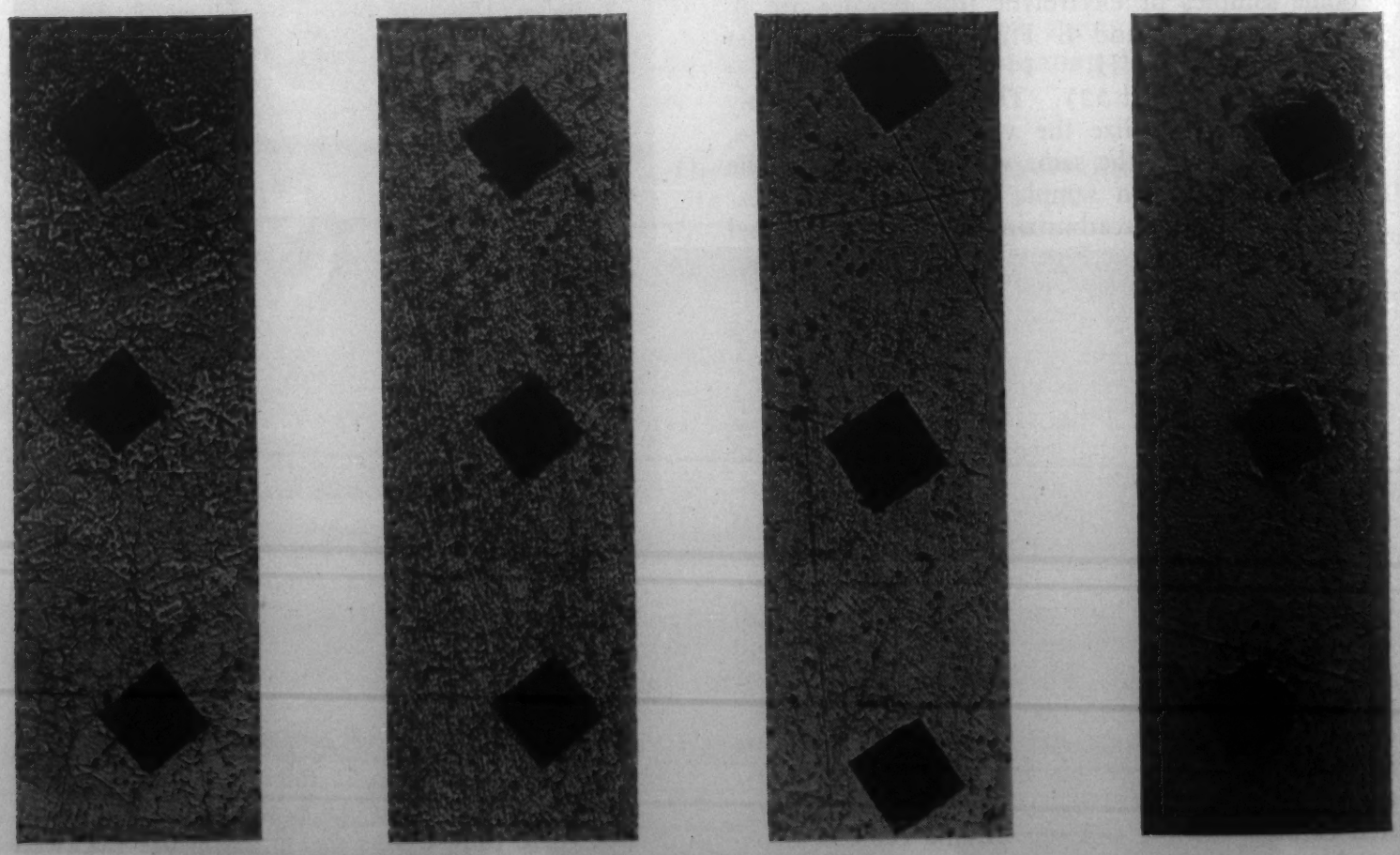
The comparison of the two hardness measurements is further shown in Fig. 10 where the hardness numbers for various densities (caused by variation in compacting pressures) is plotted against density. It is interesting to note that both curves will intersect at 100 per cent density if extended. This tends to indicate the accuracy in this testing method. Photographs of samples A, B, C, and D are shown in Fig. 11. It will be noted that the impressions left by the diamond penetrator are of uniform size indicating constant hardness numbers.

Results with Duplex Materials

Electrical contact materials are frequently composed of tungsten and copper, two metals that do not alloy. The tungsten is added to improve the wear resistance of the contacts, as copper is very soft. A conventional Rockwell or Brinell hardness tester will give "average" results, which are of little value. It is important to be able to determine the separate hardness of either the copper or tungsten particles.

Such a copper-tungsten contact material is shown

Fig. 11. Micro-hardness of iron compacts, A, B, C, D, (left to right). Each one subjected to 275 gram-pressure and photographed at 200X.



in Fig. 12. The sample was etched so that the copper and tungsten particles could be easily distinguished. With an indenting force equal to 27 grams, the difference in indentations between that in the softer copper (the large recess in the dark particle) and those in the much harder tungsten particles is easily discernible. The microhardness values of the copper and tungsten were respectively MH = 73 and MH = 420. This ability to check constituents of a compact individually is one of the outstanding features of the microhardness tester.

Another field of usage of this instrument is in investigating the diffusion and formation of intermetallic compounds when two powders that alloy readily are sintered. Copper and tin powders (in proportion of 90 per cent Cu to 10 per cent Sn) are used for making bronze compacts. If this mixture is sintered at 1475 deg. F. (800 deg. C.) for 1 hr., a homogeneous alpha solid solution is formed. Fig. 13 shows a photomicrograph of such an alloy after three indentations were made with the diamond penetrator load equal to 28 grams. These indentations were about the same and gave a hardness reading of 113.

If these tin and copper powders are not allowed to diffuse so thoroughly, an entirely different structure is obtained (see Fig. 14). In this case, the same proportions of powders were used as in Fig. 13, but they were hot-pressed for only 5 min. at 930 deg. F. (500 deg. C.). The different constituents are clearly visible. The light areas are the tin rich phase, some copper particles remain as a pure metal, and an intermediate or eutectoid phase is visible in the upper left part of the photograph.

The indenting force was the same as that used for Fig. 13. The micro-hardness number of the copper particle is 69 (about the same as the copper in Fig. 12). The indentation (upper left) in the eutectoid material gives a hardness reading of 110. The hardness of the tin rich phase is not constant possibly due to changes in alloy copper content; it varies from 216 to 305. When the hardnesses of such intermetallic compounds are known the relative amount of this phase present and the progress of diffusion can be judged fairly accurately.

These representative applications of the microhardness tester have been described to indicate the range of use of the instrument; powders, transition products, compacts, etc., all can be accurately checked with this type of instrument. With wider use, many engineers and metallurgists will find new applications that will advance both the knowledge of hardness and the science and practice of powder metallurgy.

Fig. 12. Tungsten-copper material subjected to 27 gram pressure and photographed at 460X.

Fig. 13. Bronze sintered at 800 deg. C. (1472 deg. F.) subjected to a pressure of 28 grams and photographed at 575X.

Fig. 14. Bronze, hot pressed at 500 deg. C. (932 deg. F.) subjected to a pressure of 28 grams and photographed at 575X; a is tin-rich phase, b is eutectoid, c is copper.

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(1) F. Schulz and H. Hanemann, *Zeitschrift f. Metallkunde* vol. 33, 1941, page 124. E. O. Bernhardt, *Zeitschrift f. Metallkunde*, 33, 1941, 135.

(2) H. Scott and T. H. Gray, *Transactions* ASM, 1940, page 399.

Piston Rings of Gray Iron

by TRACY C. JARRETT

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Koppers Co., American Hammered Piston Ring Div.,
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A PICTORIAL ARTICLE

THE PRIMARY PURPOSE of a piston ring is to act as a seal. In an internal combustion engine, the piston rings seal the burning gases in the combustion chamber and the lubricating oil in the crank case. In compressors, steam engines, and hydraulic installations, the piston rings seal the operating cylinders.

Piston rings have been and are being made today from many types of materials. The most widely used material is close grained gray iron. The principal reasons for using this material are its ability to withstand wear and to retain its good physical properties under varying conditions of temperature, pressures and lubrication.

The ability of gray iron to resist wear is due primarily to the type and distribution of soft, "lubricating" graphite and steadite with a tough pearlitic matrix. A typical analysis and microstructure of a gray iron used in aircraft engine piston rings is shown in column A of the table, and Figs. 1 and 2; and of a large ring used in Diesel engines, in column B of the table and Figs. 3 and 4.

Composition and Hardness of Aircraft and Diesel Engine Piston Rings

Analysis	(A) Aircraft Engine Rings	(B) Diesel Engine Rings
Combined carbon	0.45-0.75	0.60-0.80
Graphitic carbon	2.70-3.20	2.70-3.05
Manganese	0.40-0.80	0.50-0.80
Phosphorus	0.30-0.80	0.30-0.60
Sulphur	0.10 Max.	0.10 Max.
Silicon	2.20-3.10	1.20-1.70
Rockwell "B" Hardness	97-104	85-95

Fig. 1. Structure of close grained gray iron. Unetched. 100X.

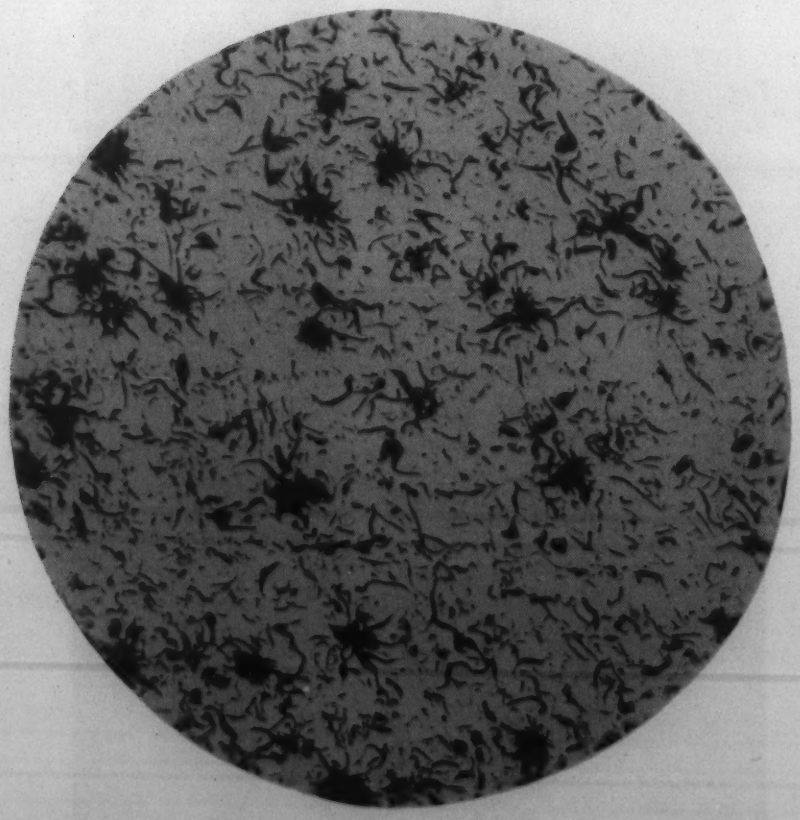


Fig. 2. Structure of close grained gray iron. Etched with nital. 500X.

An aircraft ring demands a fine grained structure, whereas large rings such as used in Diesel and steam engines require a coarser grained material. The cross-section of an average aircraft piston ring is approximately 0.125 x 0.250 in. As the cross-section increases in size, the graphite flakes become larger, and the matrix changes from a fine sorbito-pearlite matrix as in aircraft rings, to a coarse pearlite in the larger rings.

Close metallurgical engineering control is necessary in the manufacture of piston rings to insure good machinability and to meet stringent physical requirements. It is also essential that close foundry control be maintained to produce rings of small cross-section without porosity, free ferrite, and hard spots which are believed to be cementite. This control is complicated by over 30,000 different types and sizes of rings which are required by the builders of engines.

Piston rings in this country are practically all made from individual castings. There may be as many as 100 or more individual castings poured from one sprue, as shown in Fig. 8. The molding sand must have the proper moisture content, permeability, and strength to produce a suitable mold for small castings, such as shown in Figs. 5 and 6. The risers and gates have to be of such cross-section and design as to permit the cast iron to flow freely and produce uniform cooling to avoid hard or soft spots around the ring. (Fig. 6 shows a typical mold with the gates and risers).

The molds are stacked and the down pouring method is used in casting the rings. (Fig. 7). The temperature of the molten metal is controlled closely so as not to produce excessive shrinkage or an improper structure causing a poor wearing iron. Cast iron melted in a cupola with a controlled moisture content and hot blast should be of such a composition as not to produce free ferrite in the finished castings. When free ferrite is present in large quantities low tensile strength and hardness result. A section of a ring with a large quantity of free ferrite is shown in Fig. 9.

Rings with free ferrite may also be difficult to grind, as free ferrite is soft and stones have a tendency to load rapidly. This is particularly noticeable when the faces of the rings are ground parallel from castings which have a microstructure showing free ferrite. The grinding and lapping machines which perform this operation are shown in Figs. 10 and 11.

Piston rings should have good tensile strength, impact properties, and should be able to hold their tension under all operating conditions. The ring tension is generally controlled by cutting the gap from the out-of-round casting (Fig. 12).

Close grained gray cast iron with a high silicon content and a sorbito-pearlitic matrix changes very little with engine operation. It is possible, however, in installations operating under high temperatures that growth will take place over a period of time. The cast ring must have a uniform structure around the entire ring and be free from hard spots (Fig. 13) to be able to be machined freely on such operations as turning (Fig. 14), and boring (Fig. 15).

Fig. 16 shows several types of joints commonly used and typical sections of compression and oil rings. Figs. 17 and 18 show the variation in sizes of cast iron piston rings manufactured today, and it can readily be seen that close engineering control — both metallurgical and mechanical — is necessary to produce rings of these two extreme sizes and still have them perform equally as well in their particular applications.

Fig. 3. Structure of open grained gray iron. Unetched. 100X.

Fig. 4. Structure of open grained gray iron. Etched with nital. 500X.

Fig. 5. All molds are made of green sand having controlled physical properties and moisture content. Pneumatic molding machines are used.

Fig. 6. A piston ring mold, showing method of gating, feeding and risering.

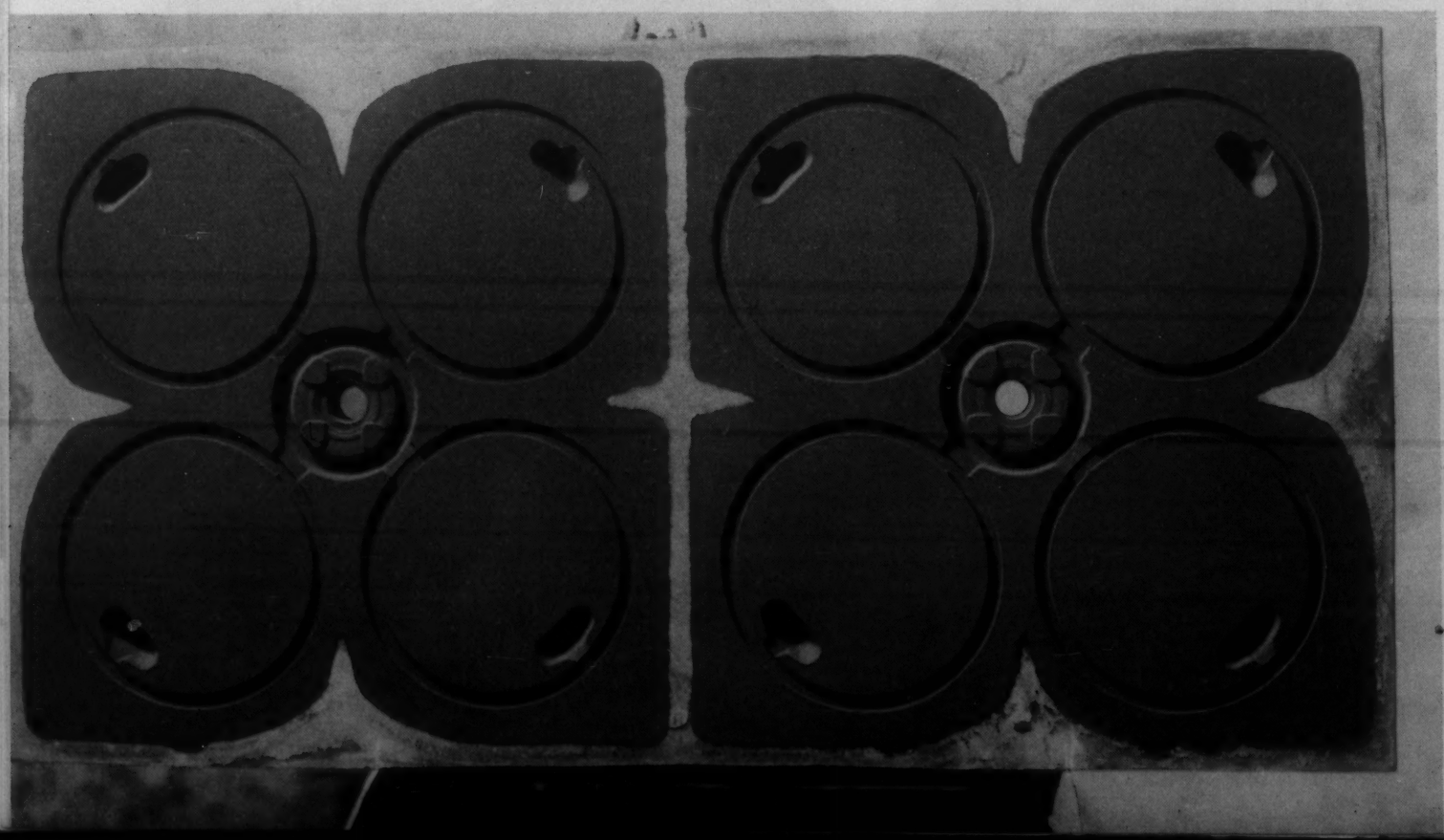


Fig. 7. Piston rings in the making — molten cast iron being poured into stacks of molds.

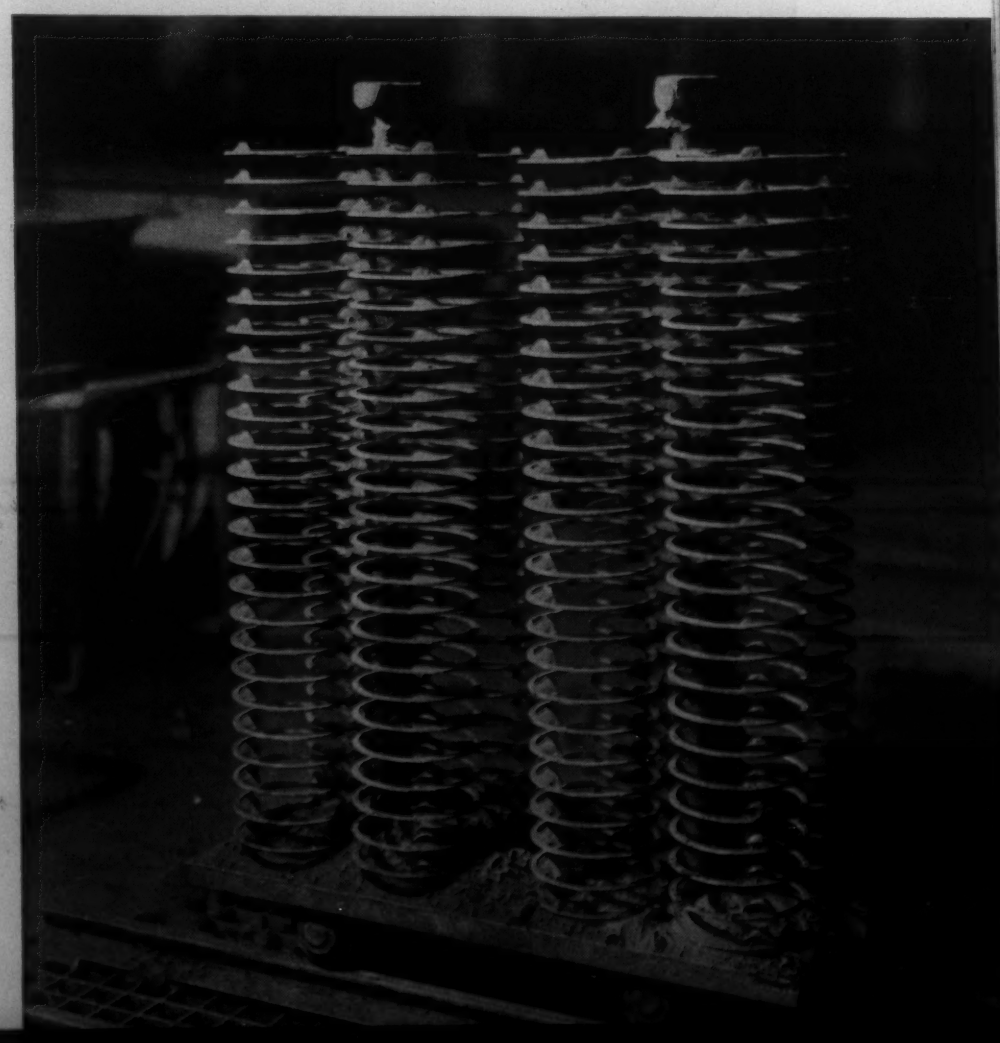


Fig. 8. Ring trees of as-cast rings with sand removed and ready to be stripped from sprues.

Fig. 9. Structure of gray iron with free ferrite. Etched with alkaline sodium picrate. 500X.

Fig. 10. Rough face grinding. The as-cast rings after sand blasting and snagging are run through large grinding machines to bring them down to the proper thickness, and make the side faces flat and parallel to each other.

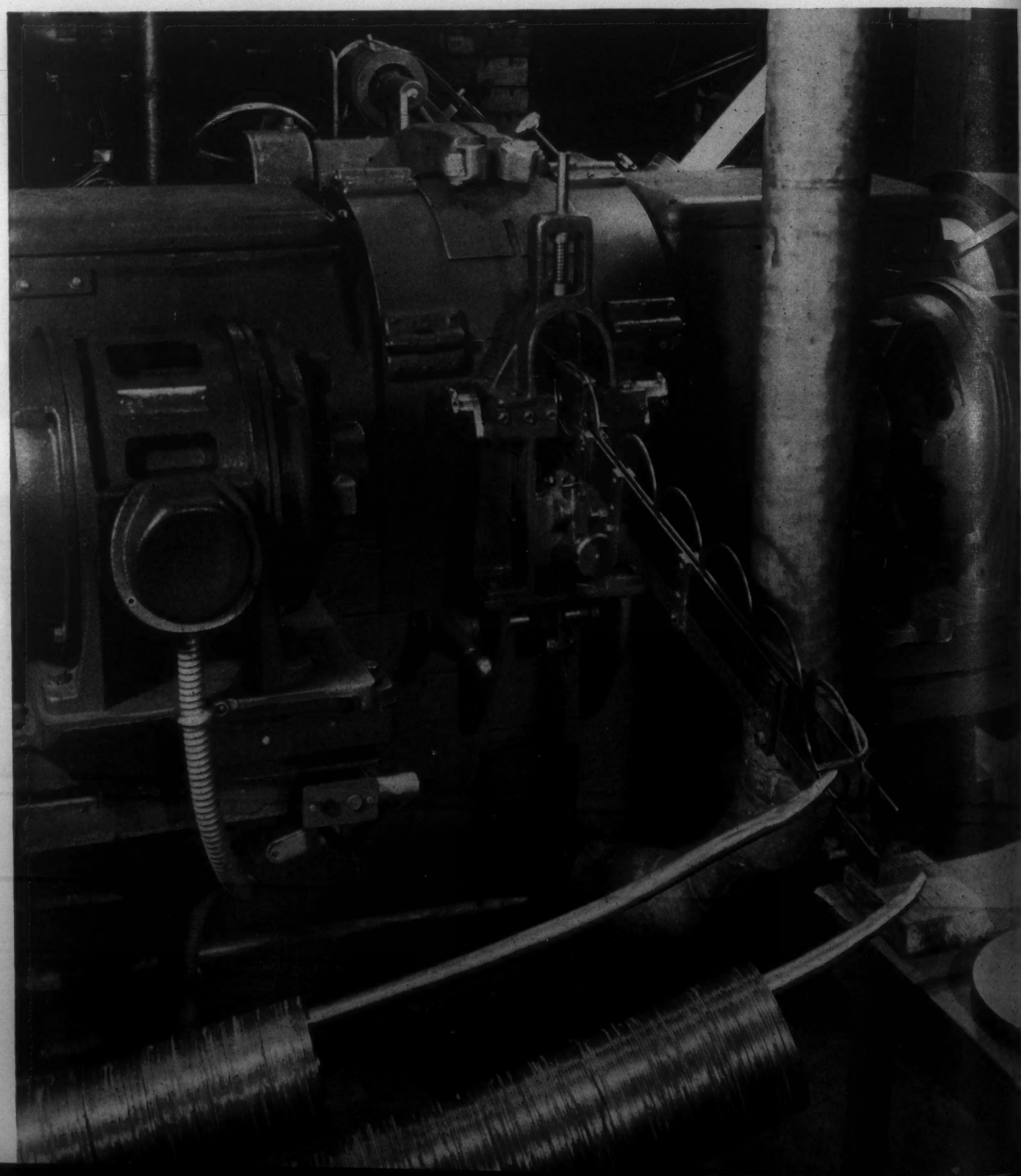


Fig. 11. Surface finish — as the final operation, the rings are hydrolapped to the correct thickness controlled to 0.0002 in., and specified surface finish of 6 microinches as measured by a profilometer.

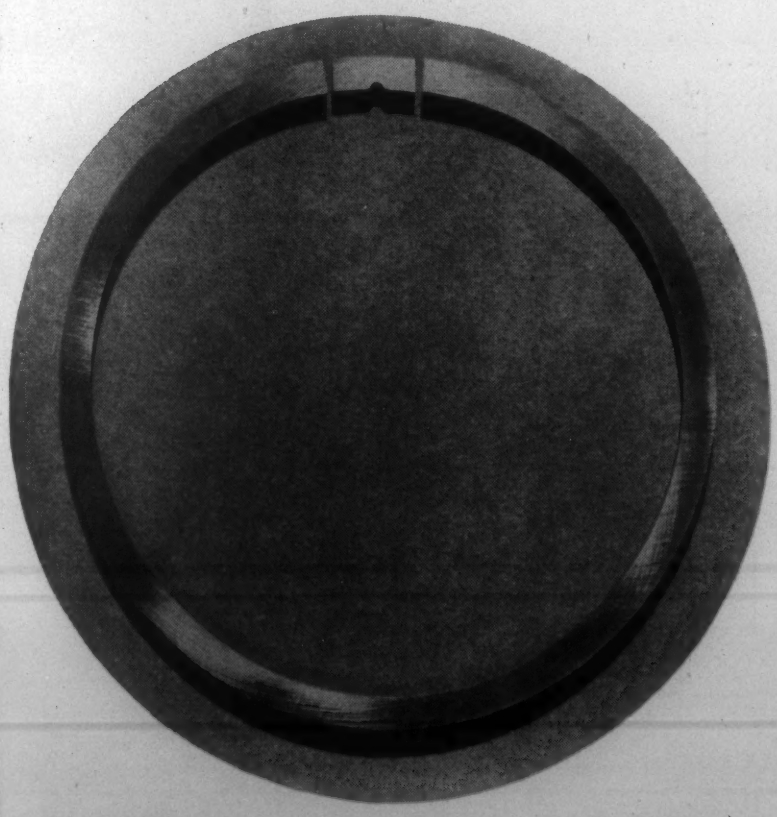


Fig. 12. Tension control — the tension and free gap are controlled by the amount of metal removed from the out-of-round casting. Hammering the inside diameter also aids in controlling the above properties.

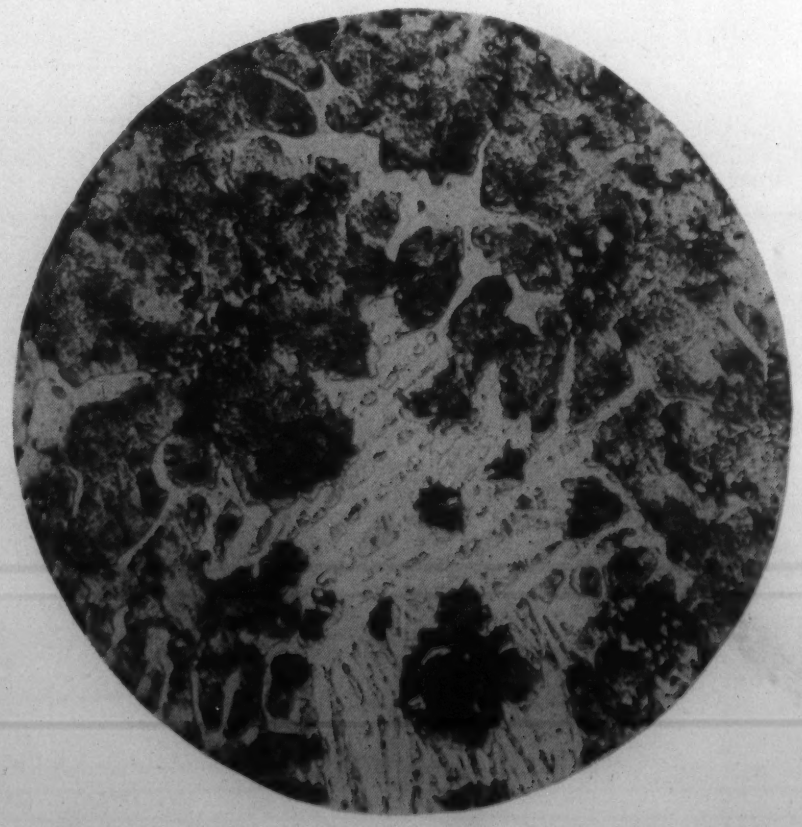


Fig. 13. Structure of close grained gray iron with cementite area causing hard spots. Etched with nital. 500X.

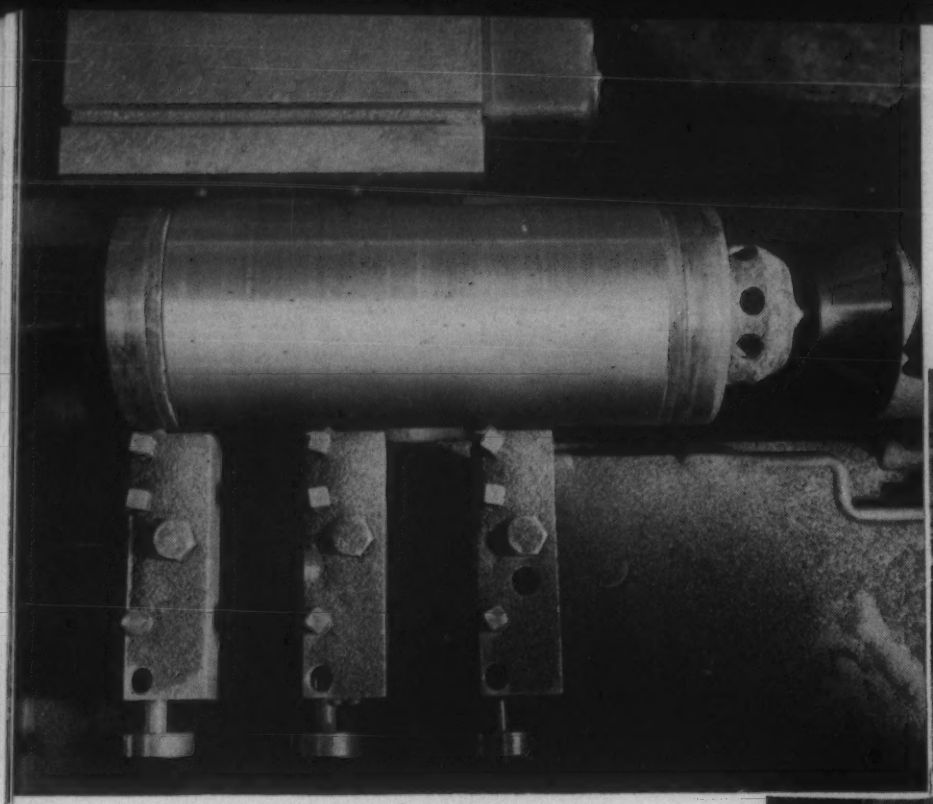


Fig. 14. Finish turning — the rough turned rings are locked on an arbor and finish-turned to within 0.0005 in. of specified ring diameter. Note the gaps in rings to provide for thermal expansion in engine operation.

Fig. 15. Controlling wall thickness — the finish-turned rings are placed in a cup and bored to the required wall thickness.

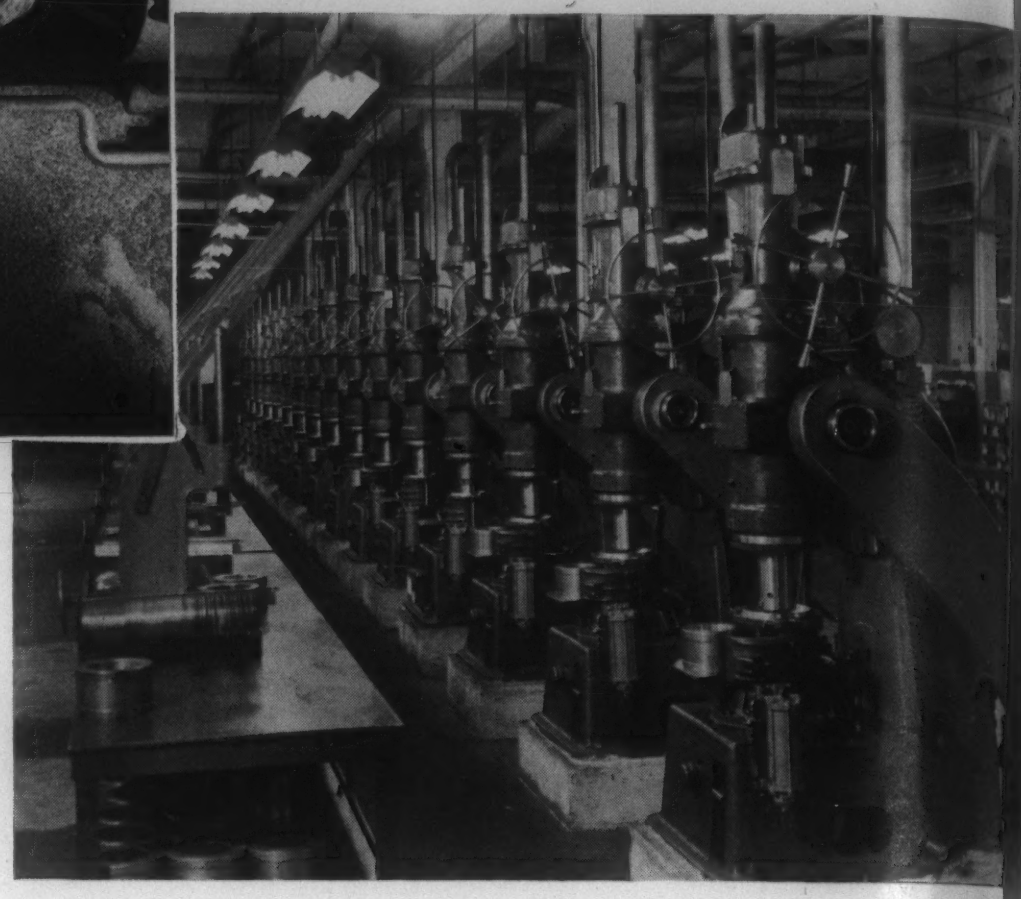
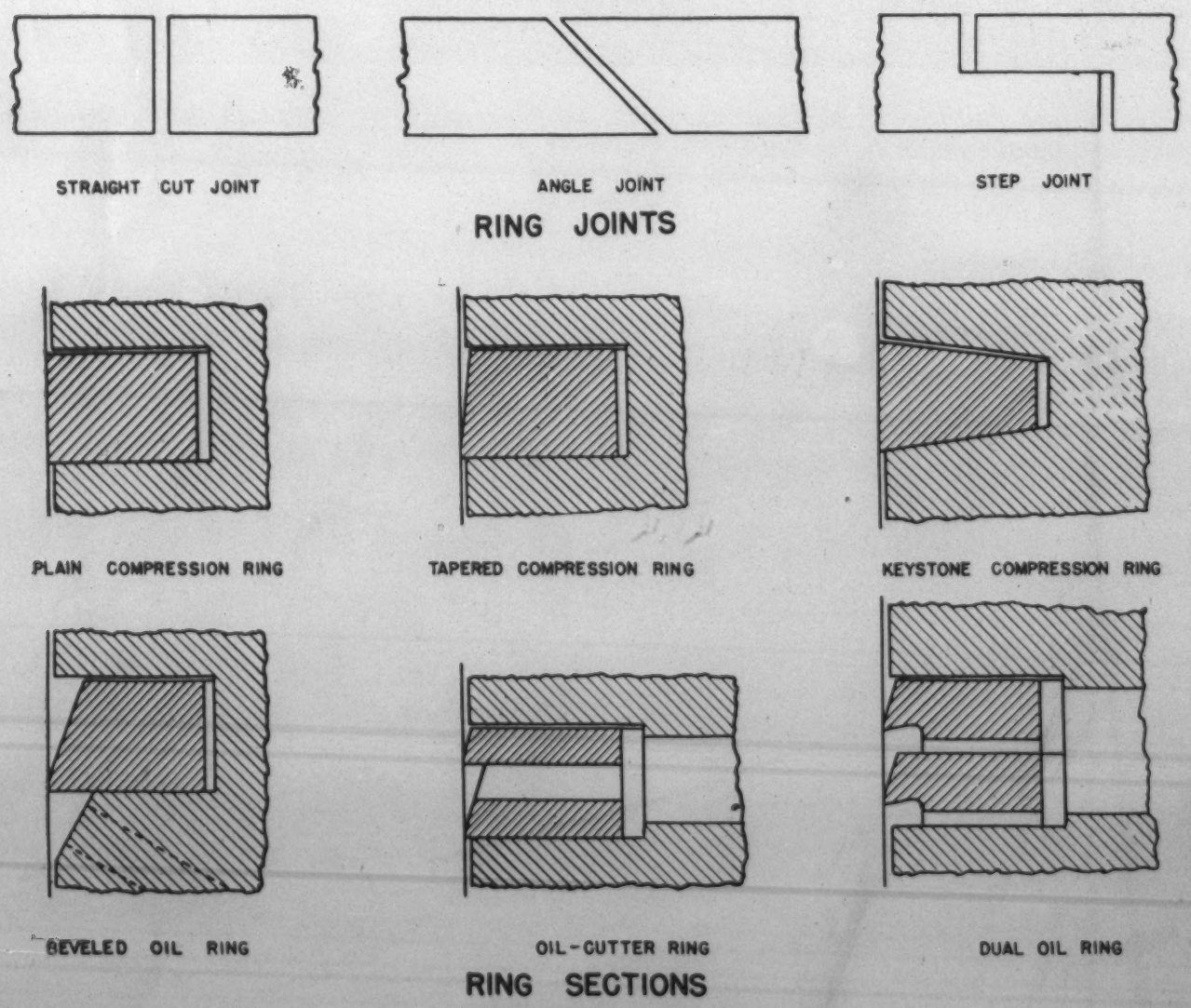


Fig. 16. Several types of joints commonly used and typical sections of compression and oil rings.



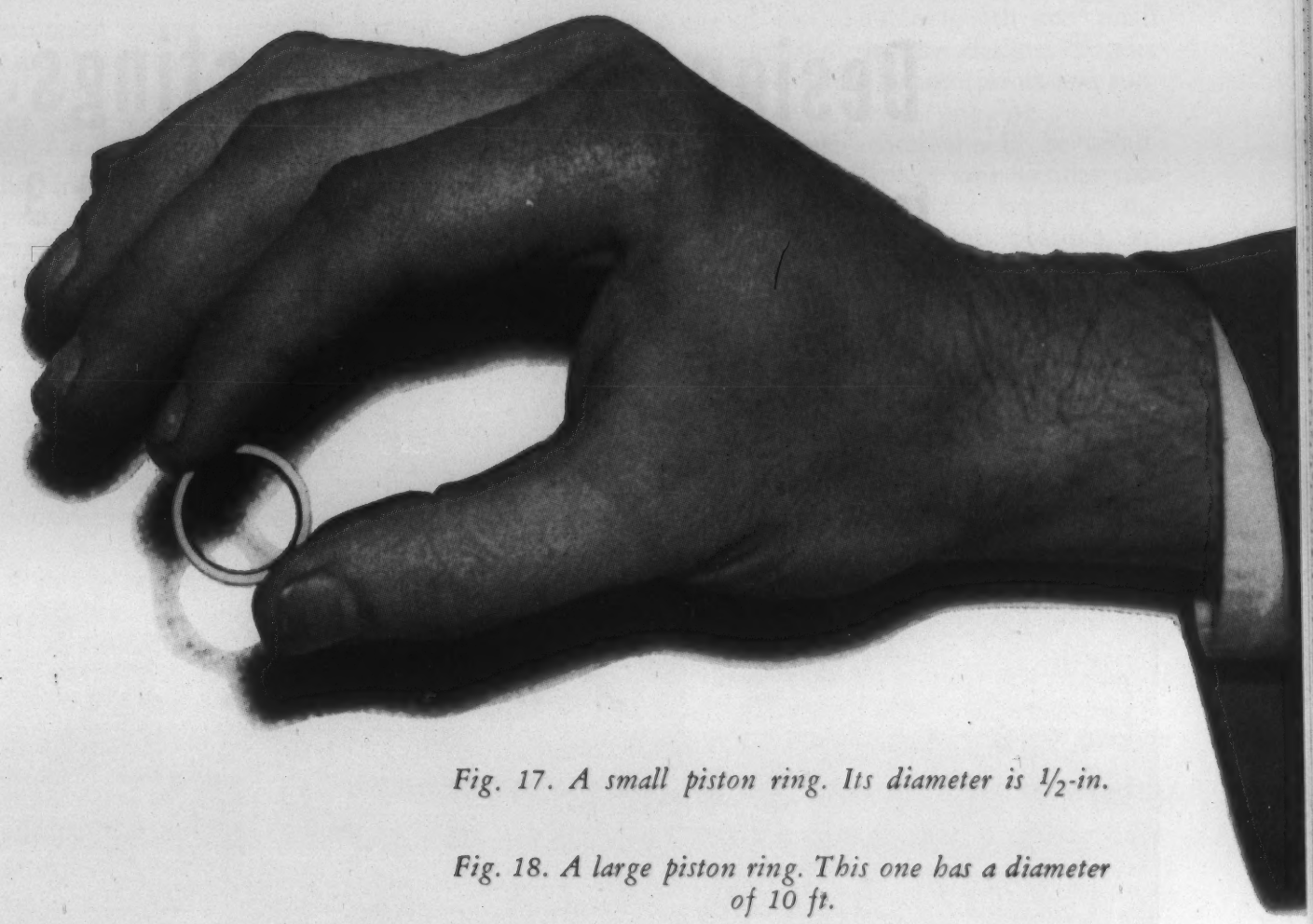


Fig. 17. A small piston ring. Its diameter is 1/2-in.

Fig. 18. A large piston ring. This one has a diameter of 10 ft.

Design of Sand Castings

for Quality Production —Part 3

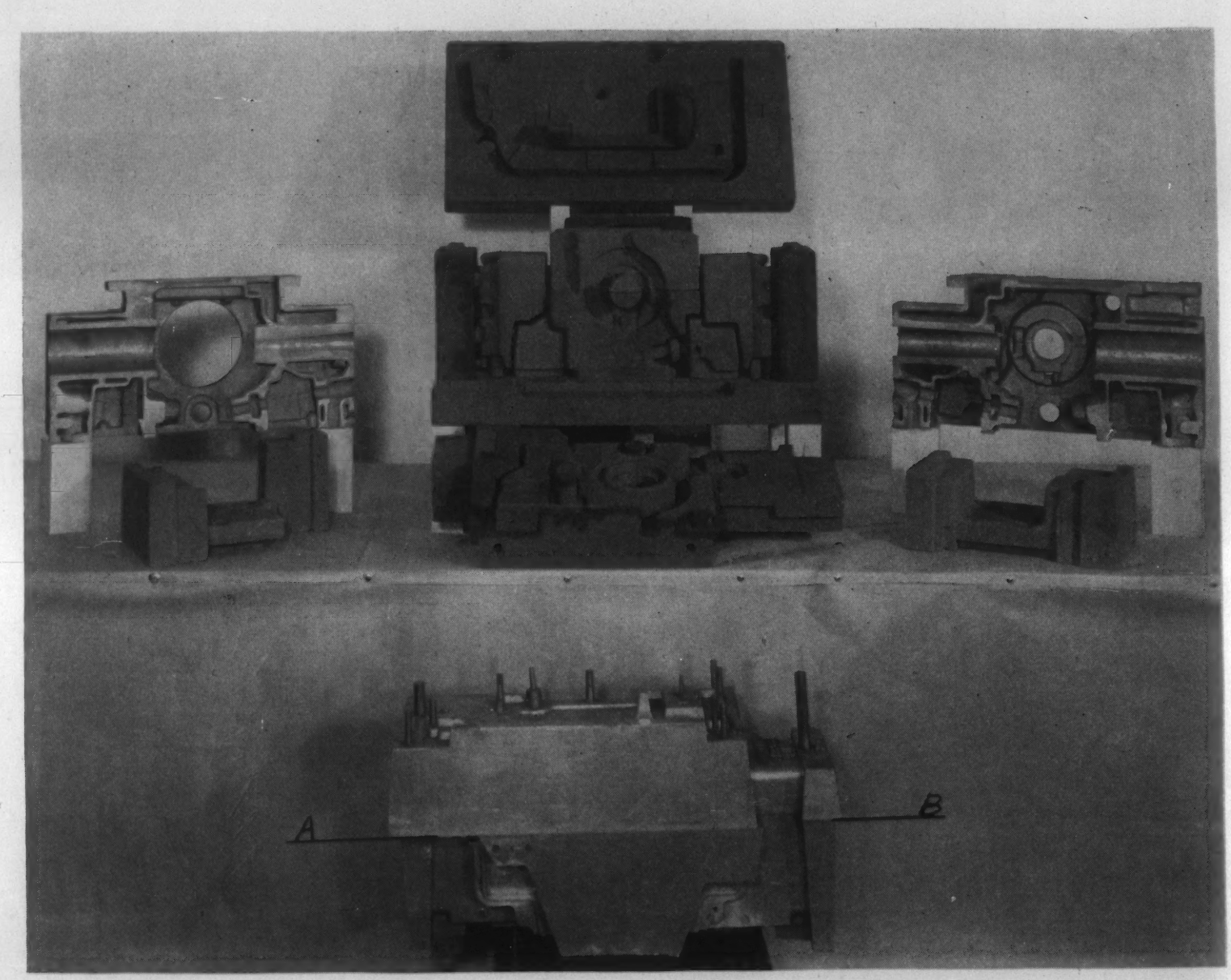


Fig. 20. A complicated casting design, the manufacture of which is made possible by the use of cores. The cores shown were set in a machine made mold.

by N. F. HINDLE

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Chicago

This is the concluding instalment of Mr. Hindle's broad review of design principles that designer and foundryman alike should remember when planning the manufacture of sand castings on a quantity-production basis. A useful summary of basic design-rules is included. —*The Editors*

Cores

Cores are masses of sand placed or created in molds to form cavities at desired locations in the castings. Cores usually are made of baked sand mixtures. If a design requires such cores, core boxes must be provided for making them. These core boxes are a part of the pattern equipment, as are core dryers which are often required to keep the cores in shape while they are passing through the baking cycle. Cores must be inspected, sometimes pasted (if made in sections), sometimes coated or otherwise treated before they can be inserted in the mold.

As all these items add materially to costs, dry sand cores should either be eliminated, or their num-

ber should be minimized except where the benefits gained outweigh the extra cost. Often the use of dry sand cores is a necessity and many castings today require that they be used. Cores not only save metal and reduce machine work but often have an important effect in helping to maintain sections of fairly uniform thickness. These are a great advantage and in many instances they outweigh the extra cost of the casting itself including the core work required. Fig. 26 shows the cores required for a complicated casting. The use of cores made possible the manufacture of this design as a unit.

Elimination of Interior Cores. Designs sometimes can be such that the pattern can be made to leave its own green sand core or cores. Fig. 21 shows two views of a casting requiring the use of complicated interior dry sand cores, elaborate and expensive core box equipment and special attention during production. Fig. 22 illustrates the redesigned casting which eliminates the use of interior dry sand cores by permitting the pattern to leave its own green sand core when withdrawn from the mold. Some cores were required to produce the brackets and ribs on the exterior surfaces, but the equipment was simple and inexpensive and production cost of the casting was much lower than in the first design.

The ideal casting, both from the viewpoint of the foundry and from that of economy, is one which can be molded to leave its own green sand core or cores. Though designers cannot always take advantage of this fact, they should do so whenever possible without undue sacrifice in other directions, as cost is then minimized.

Cored Holes. In addition to being used to create major cavities and contours, cores often are used to form holes which are later drilled to dimensions, thus saving machining time as well as metal. The minimum size hole which can be cored varies for the different metals as well as with other conditions. A core for an iron sand blast nozzle not over 3/16 in. in diameter functioned perfectly when surrounded by relatively heavy metal sections, but this core was so critical that six grains of sand of improper size in the one section was the difference between success and failure.

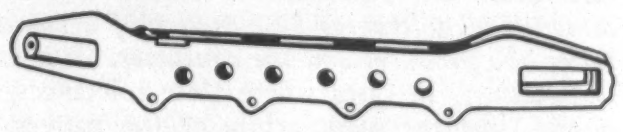
On the other hand, it is sometimes advised that no hole smaller than 1 in. diameter should be cored in sections of steel castings over 2-in. thick, and that cores for such castings should not have a diameter less than half the thickness of the wall they pierce. Since the number of variables are so great, no fixed rules as to minimum core size is given. The matter is one which should be discussed with the foundryman. If there is any doubt, however, that the insertion of a small core to provide a hole, say for a bolt, will cause casting trouble or will make core removal difficult, and hence increasing cleaning cost, it is better to require that the hole be drilled.

Core Length vs. Diameter. Core length in relation to diameter is especially important in steel castings but should be given serious consideration in all castings where cores of considerable length and small diameter are contemplated in the design. Slender cores must be anchored firmly by core prints and supported in some manner to prevent sagging.

If possible, such slender cores should be avoided for at least two reasons. First, a long slender core necessitates the use of chaplets for support, and chaplets should be avoided, if at all possible, especially in castings which must withstand pressure. It is difficult to secure complete fusion of chaplets with the metal, thus leaving a potential source of a flaw or porous spot.

Secondly, when a long thin core is surrounded by massive metal sections, the cleaning of the core from the casting is an expensive process. In such cases, the pressure of the liquid metal often is so great that it is forced into the core between the grains of sand so that the core becomes a mass of metal and sand. The time necessary to remove the core and clean the casting surface in such instances is so high as to defeat the purpose of the core. If such cores are demanded, the purchaser must expect to pay extra for core removal.

A cored recess or hole is most likely to be cleaned with a minimum of labor and with a maximum of effectiveness (a) when the opening thereto has an area proportionately large as compared with the thickness of the surrounding wall of metal; (b) when the recess or hole is not of excessive depth as compared



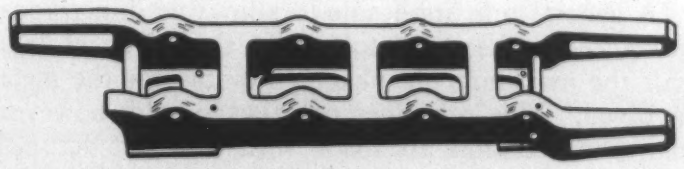


Fig. 21. Casting design which involves the use of complicated interior cores in the mold making for high core cost, high molding cost and extra cleaning cost.

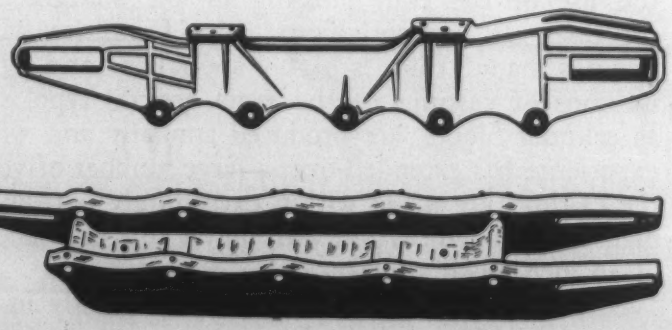


Fig. 22. Same casting as Fig. 21 redesigned to leave its own green sand core, thus avoiding the use of the expensive core boxes required for the design shown in Fig. 21. Simple, low-cost core box equipment was required to make the cores used to produce the exterior brackets and ribs. The smaller, simpler cores, were made and set at lower cost than the larger, more complicated cores required by the design in Fig. 21.

with outlets accessible for removing the core used to form it; (c) when the recess or hole, if long, is straight rather than curved (thereby facilitating the use of cleaning tools); and (d) when suitable outlets are provided not only to facilitate cleaning but to aid in firmly placing the required cores.

Venting. Venting of cores also is important from the design standpoint. Internal cores (that is, those largely surrounded by metal), require adequate provision for venting the gases generated when the core comes in contact with the molten metal. In such cases, the designer should provide for the passage of this gas through one or more prints.

Clean-Out Holes. Some castings must be designed in such a manner that a core is entirely surrounded by metal save for relatively small clean-out holes, though such a condition is to be avoided if at all possible. In such castings, however, clean-out holes for the core must be provided. Such holes may later be plugged before, or subsequent to, machining or by welding. Fig. 23 illustrates a section through such a casting.

Dimensional Tolerances

The general design of castings, the number of castings to be produced, and their size are three of the most important factors influencing dimensional tolerances. This fact makes it *essential that allowable dimensional tolerances be a matter of agreement between the producer and the consumer.* It is especially necessary, in cases where close tolerances are required, that the manufacture of the pattern equipment be under the supervision of the foundryman.

A general rule applicable to allowable dimensional tolerances is that such tolerances should be at least half the maximum shrinkage allowable for the metal involved. This rule does not always hold, however, and many castings are made with sufficient accuracy so that no machining or finishing, other than that normally done in the foundry cleaning department, is required to fit them for use.

This is especially true of malleable iron castings when purchased in sufficient quantities to justify the use of the coin pressing or die straightening processes. In automotive production foundries, where castings manufacture is highly specialized and where millions of castings of the same general type, such as cylinder blocks, are produced annually and where experience has extended over a large number of years, the castings are made within exceedingly narrow dimensional tolerances and with only a few thousandths of an inch finish allowance.

Such close work is possible, however, only in the case of highly specialized quantity production and long familiarity on the part of the foundryman with the given design. The designer cannot expect a new casting (even though the order for it may require production in large quantities) to be made within such narrow dimensional limits. Only experience and, through it, an understanding of the vagaries of mold and metal behavior in a given casting, makes the specification of extremely narrow tolerances feasible. In the Table are given, *but only as a very rough guide,* the approximate maximum tolerance that can be held without machining, on castings of various classes. Minimum tolerances are sometimes specified within a few thousandths of an inch, as cast, but are permissible only under favorable conditions, as previously mentioned, especially when malleable iron castings may be coin pressed or die straightened.

Also, as a result of careful planning and cooperation with the foundryman and patternmaker on the part of the designer, and of careful study of the production operations on the part of the foundryman (as determined, for example, by the production of sample castings) closer tolerances than those specified in the table are obtainable, even on medium sized castings. On the other hand, with very large castings, it may be necessary to require wider tolerances than those listed in the table.

If the designer does *not* seek the cooperation of the producer and does *not* afford him the opportunity of careful production planning and a study of the vagaries of the individual casting design, as mentioned above, *closer* tolerances than those given in the table should *not* be specified. The most important of the three general considerations which influence dimensional tolerances are general design or shape but the size of casting also is important.

Nothing is gained, of course, in specifying close tolerances when wider ones meet every requirement, and a great deal of delay and misunderstanding may result if tolerances are set closer than they need be.

Because of the wide variation in size and design and in the production operations involved, any general statement concerning tolerances which may be expected by the engineer for a given design necessitates many reservations. A competent foundry, with proper engineering and control staff, can produce the best possible castings from a given design when allowed to cooperate with the designer from the inception of the casting until actual production is begun.

Machine finish allowances naturally should be held to a minimum for economy in the machining operation. The allowance varies usually with the size of the casting. *As a guide,* the machine finish allowances for various metals, as given in a table in the Cast Metals Handbook may be used but particular attention should be paid to the notes at the bottom of the table. It should be remembered, as previously stated, that greater machining allowances should be specified for parts cast in the cope of the mold than for those cast in the drag.

Table of Approximate Maximum Tolerances for Castings

Metal	Minimum Overall Dimensional Tolerance, In.
Cast iron	1/16
Malleable iron	3/32
Cast steel	5/32
Aluminum alloys	5/64
Magnesium alloys	11/64
Brass	3/32
Bronze	1/8

Use of Metal Inserts

Castings are sometimes so designed as to call for the use of metal inserts to be cast in place. Such inserts invite trouble and extra cost. Not only must these inserts be kept scrupulously clean, that is, free from dust, rust or other oxide on the surface; grease, oil and even the perspiration of the hand, but, in some instances, they must be preheated so as to form as close a bond between the metal and the insert as possible.

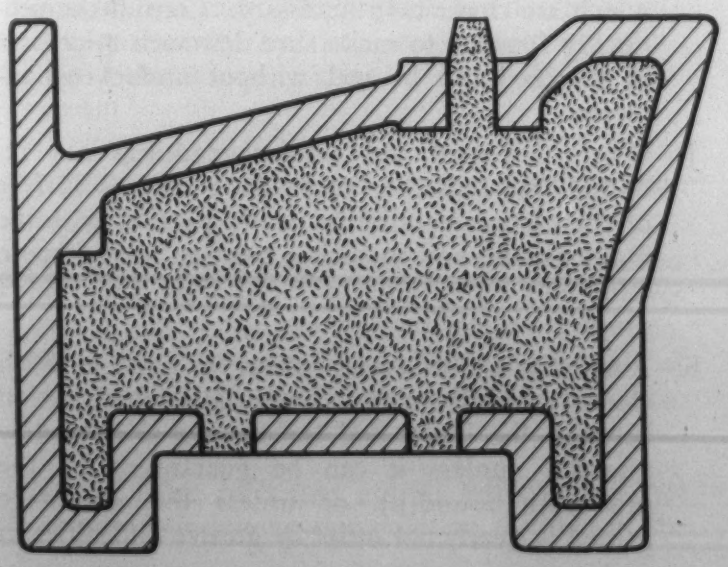
Even when pre-heated, the temperature differential between the liquid metal and the insert is considerable. The liquid metal must heat the comparatively cold metal insert, thus causing it to expand, while the molten metal is cooling and contracting because of heat absorption by the insert. Hence the possibility of local stress reversals, converting the stress over a small area from tension to compression, must not be overlooked. If inserts are used, they should be knurled or grooved to insure a good mechanical bond, as this helps to hold them securely even though actual fusion with the metal of the casting may not occur. Sufficient metal must be provided around such inserts to eliminate the chance of cracks developing adjacent to the insert.

Size of the Mold

The design of a casting should be considered from the standpoint of the size of the mold necessary to make the casting. As the mold size increases, the cost per mold increases. Sometimes, the total mold bulk can be reduced by making the part as two or more castings, though this is likely to involve extra machine work if the two parts have to be joined later. In other instances, the part may be redesigned to take a smaller flask than required originally, as shown in Fig. 24. In any event, economy dictates the use of the smallest possible casting which will meet requirements.

When the castings are to be made by a foundry already selected, it often contributes to economy to learn what flask size the foundry possesses. This makes it possible to design the casting to utilize the flask equipment on hand and thus avoid the chance that special flask equipment for a particular job will have to be purchased.

Fig. 23. Section through aluminum alloy cylinder head showing core print left to provide a vent and to permit removal of core sand when casting is cleaned.



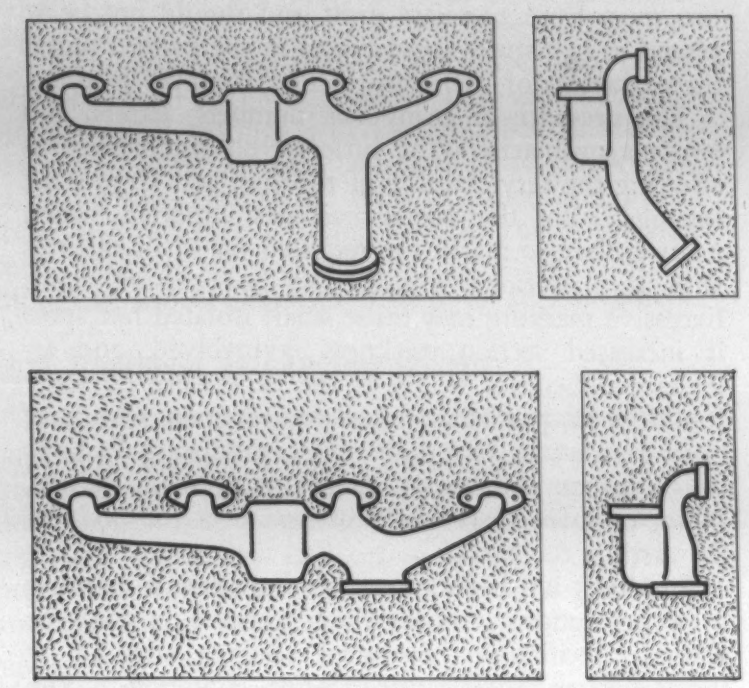


Fig. 24. Top, and end view of a manifold as first designed. Below, manifold redesigned to permit a reduced volume of sand, thus reducing mold cost, as smaller flasks are required.

Finishing Costs. Where cost per casting must be minimized the effect of cleaning and finishing costs deserves study as, in some instances, such costs outweigh by far the molding cost or even the total cost of the casting itself, especially if polishing and plating happen to be required.

The designer should keep in mind the expense involved in cutting off risers in inaccessible spots, especially on high-shrinkage alloys such as manganese-bronze or iron-aluminum-bronze or on alloys difficult to machine. Also, the difficulties encountered in cleaning small diameter holes in heavy sections, especially holes which are not straight, should not be overlooked. Where smoothness is an important factor affecting finishing cost, as is often the case, it may be expedient to choose an alloy which can be cast with a relatively smooth finish even though this may increase metal cost. It is best to avoid recesses which are hard to clean and surfaces which are difficult to machine (when machining is necessary) unless it is certain that the extra cost involved is justified by some compensating advantage.

Marking Castings. It is usually desirable that the foundry's trade mark appear on the casting, frequently accompanied by the pattern number, part number, metal symbols, and other descriptive marking. In general, however, such markings should involve as few characters as possible and be limited to the drag side as well as to an area which will not unduly hamper the foundryman's choice of gate inlet locations. Let-

ters must have adequate draft and should not be so placed as to require loose pieces in the pattern unless the extra cost of such construction is amply justified.

The presence of many cast numbers, letters, and symbols ordinarily is of little or no significance as affecting the serviceability of medium and large sized castings. But the matter becomes important when many embossed marks are required on small castings with thin sections which must be pressure tight. Excessive marking may cause small isolated hot spots if increased section thickness is involved, and attendant difficulties. This is the experience of many foundrymen, particularly steel foundrymen, who have been faced with the problem of producing castings of 3/8-in. or less metal section with many letters, 1/8-in. or more in height, scattered over the body of the casting.

Emphasis has been given to the matter of marking in a precautionary note which appears in each of several specifications for steel castings adopted by the American Society for Testing Materials. The note reads thus:

"The resistance of a sand mold to the erosive effect of inflowing metal is aided by smooth mold surfaces. Cast identification marks are formed by making indentations on the face of the mold. For the prevention of small defects caused by dislodged particles of molding sand, there should be provided the minimum feasible number of cast identification marks."

Summary of Rules for Design

From the foregoing, it should be apparent that there are no inflexible rules governing the design of sand castings. It is also clear, however, that there are certain conditions which the designer should strive to meet and others that he should avoid when laying down a design of a casting, especially if it is to be produced in quantity at minimum cost. These desirable procedures are summarized below. It should be understood that the rules given are general and that there may be valid grounds for departures from them to secure certain results not attained otherwise.

The rules may serve as a "check list" which the designer may employ effectively when a design is in progress or nearing completion. If he finds that any of the rules are violated and that he can change the design to avoid the violation without sacrificing something more important, the casting will be produced with a minimum of difficulty in the foundry and probably at a lower cost than if the rules are neglected.

The following procedure is suggested at the inception of the casting design.

1. Make a sketch of the proposed design in which
   (a) Sections are maintained as nearly uniform in thickness as conditions permit, or
   (b) Where uniformity in section thickness is not feasible make the transition gradual — never abrupt, blending heavier sections into light ones.
2. Seek the constructive criticism of the competent foundryman who is to make the castings and endeavor to follow his suggestions where they appear proper from a design standpoint, with a view to simplifying and avoiding difficulties in the production of the castings.
3. Explain to the foundryman the conditions that the casting must meet, where it fits into the total assembly, and what functions it must perform.

By observing the following rules in the preliminary drawing, the foundryman will have minimum suggestions to offer; their purpose, aside from being an aid toward securing sound castings is to promote ease of manufacture.

A. Visualize the casting in the mold, and design it so that, as placed in the mold, it will solidify regularly and progressively from the lowest to the highest point.

B. Avoid designing castings so that the heavy sections occur below lighter sections when the casting is in the mold, thus making adequate feeding of the heavy sections difficult or impossible.

C. Design the casting so that it can be poured easily in all of its parts with a minimum number of risers, and so that the risers, when required, are located at the highest point in the mold and so that the last fluid metal is contained in the riser.

D. Use fillets at junctions and especially at inside corners, but avoid making them so large as to produce excessively heavy cross-sections at the junctions.

E. Employ ribs where they help to avoid warpage or are needed for extra stiffness and can be used to lower weight and still not interfere with the ready preparation of the mold.

F. Where intersecting ribs or junctions of members result in undue concentration of metal with resulting hot spots, consider the feasibility of staggering or, in the case of large castings, the use of simple cores at the intersections to equalize cross-section at the junctions.

G. Avoid the use of deep pockets in castings as such pockets generally involve an undue increase in cleaning costs.

H. Aim to make the casting as simple in structure as conditions permit, investigating the possibility of using two or more separate castings, to be joined subsequently if a one-piece casting is highly complex and gives promise of lower over-all cost if cast in parts.

I. Avoid the use of as-cast dimensional tolerances which are closer than necessary. Consult the producing foundry to make sure that such tolerances as specified can be met without undue cost increase.

J. Where lettering and similar markings are required, see that they come on a face or surface of the casting parallel or nearly parallel with the mold parting and in such a position as to impose minimum restrictions to metal flow and proper progressive solidification.

K. Avoid the use of metal inserts, if possible. Such inserts should be avoided especially where fusion between the insert and the casting is absolutely essential (unless it can be guaranteed by the producing foundry) or unless the advantage gained is clearly not offset by greater difficulties in

production than the proper insertion after casting would entail.

L. When castings are exposed to view in the finished product, see that they are as sightly in appearance as conditions permit, with simple and flowing lines and exteriors free from unnecessary projections.

M. Keep the size and weight of the casting, and hence the sizes of sections, as small as is consistent with adequate performance of function.

N. Adhere, as far as conditions permit, to designs which simplify both the pattern equipment required and the molding procedure, avoiding the use of loose pieces in the pattern, if possible, and using them only where desired results cannot be secured by some other method. Loose pieces in the pattern generally mean increased molding costs.

O. Avoid the use of designs which involve irregular parting lines in the pattern equipment when a casting which meets requirements can be designed to have its parting line in one plane, as straight pattern parting lines usually result in lower molding costs than if irregular parting lines are used.

P. Permit the pattern equipment to be made with ample draft so that the pattern can be withdrawn readily from the mold without injury to the latter. Allow the use of as much draft as appearance of the casting and other factors (such as avoiding higher machining costs than are necessary or when too much draft causes too great an increase in section size at points where proper feeding is impossible) require. Ample pattern draft means easier molding.

Q. Avoid designs in which more dry sand cores than are essential are used, as designs by which the pattern can be made to leave its own green sand core in the mold generally are the most economical to produce.

R. Where dry sand cores are essential, make them as few in number and as simple as possible. Provide for points of adequate core support in the mold. In castings which must be pressure tight, the use of cores which must be supported by chaplets should be avoided.

S. Make sure that interior cores, which cannot be avoided in a casting and which are nearly or entirely surrounded by metal, can be properly vented and that adequate clean-out openings are provided.

T. Avoid designs wherein cores are so placed or are so slender that subsequent removal from the casting is difficult.

U. Avoid the use of long, slender cores surrounded by extremely heavy metal sections, as such cores are difficult to remove in the cleaning operation. When such cores are unavoidable, they should at least be straight and ample anchorage for them should be provided in the mold.

Some of these rules may appear self-apparent, yet almost any foundryman can point to castings in the design of which seemingly obvious rules have not been heeded, with consequent needless increase in cost of castings. The rules do not, of course, cover all features of design but, where they are followed, production of castings will be simplified and costs lowered. It is, at least, worthwhile to check any casting design against the rules or procedures listed above and, where it is found that the rules have not been followed, to see whether the design can be altered to avoid this with benefit to all concerned.

Heat Treatment as Affecting Design

Designers of castings should properly take advantage of the fact that certain cast metals may be heat treated to develop maximum physical properties, as this can be made to reduce the weights of the casting and sometimes its cost. Maximum physical properties in many metals are obtained by quenching and drawing or tempering heat treatments. In designing castings to be so treated, it is well to remember that, in such treatments, heavy sections do not cool so rapidly as thin sections.

When there is great variation in section thickness within a casting, the quenching treatment may develop stresses sufficient to rupture the thin members of the casting. The possible development of such stresses in a design may preclude quenching, in water, oil or air. In some instances, even though water quenching and subsequent tempering may be desirable from a physical property standpoint, the design may limit the applicable treatment to an oil or air quench with a sacrifice in the desired properties. For these reasons, castings to be heat treated require scrupulous adherence to the use of sections which are uniform in thickness or, if sections vary, to the use of gradual blending from thick to thin, as these factors greatly influence the possible increase in rejects, which, in turn, correspondingly affect costs.

Conclusions

From the above discussion, it is evident that the two main principles which should be observed in the design of castings are uniformity of section thickness and blending of heavy sections into light ones where section uniformity is impossible. While, as already indicated, many other considerations enter into the design of castings that may be made in large quantities in the most economical manner and at the same time be of greatest usefulness, adherence to the two principles mentioned is of paramount importance if cost is to be minimized and satisfactory castings secured.

The author gratefully acknowledges his debt to those who have enunciated certain fundamentals of casting design in articles appearing in engineering and metal working publications, books, and society and association publications of interest to the foundryman as well as to casting designers. The subject is a complicated one. Little strictly basic information is available, though considerable is in process of being accumulated. Designers can assist the foundryman in his search for such information. They can,

in turn, by seeking the foundryman's advice on casting production, learn to adapt their designs to efficient quantity production. In short, through cooperation, the designer and foundryman can help each other and, at the same time, benefit all others concerned.

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A LETTER TO THE EDITOR

The National Emergency Steels

To the Editor: One of the most important metallurgical developments of 1942 was the development of the National Emergency Steels. The guiding principle in making up the specifications for these steels is well expressed in the following statement:

> "Current recognition of the truth that a small percentage of several alloying elements is more beneficial to the general properties of steel than a relatively large addition of a single alloying element, has led to the specification of satisfactory steels with unusually low alloying contents." (Priestley, METALS AND ALLOYS, Jan. 1943—page 54)

To my knowledge, the first one to clearly recognize this principle and to apply it in practice was the eminent Swedish metallurgist, the late V. N. Hybinette, perhaps best known for his work in the smelting and refining of nickel.

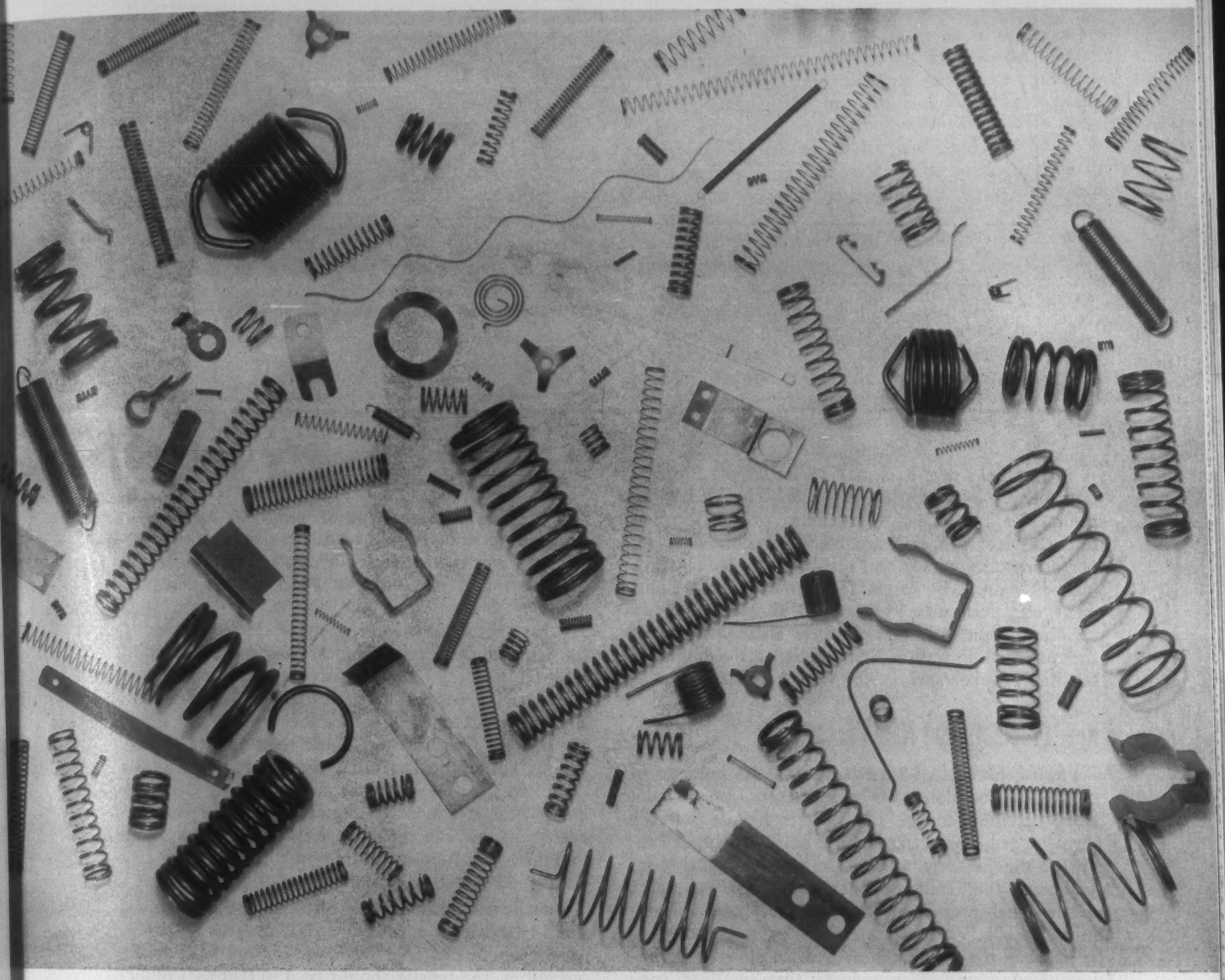
About 20 yrs. ago Mr. Hybinette, in collaboration with his son Victor, also deceased, put the principle to practical use in a number of aluminum alloys, in which he added as many as 8 different alloying elements, most of them in quantities of 0.2 per cent or less.

He propounded the principle on many occasions over a number of years, a fact that can be easily verified by well known members of the metallurgical profession. I feel that Mr. Hybinette's pioneering work in this field deserves to be remembered.

ANTON GRONNINGSATER

230 Park Ave.
New York.

Quality Inspection of Beryllium Copper



Beryllium-copper coil and flat springs "micro-processed" to best spring properties for each lot. (Courtesy: Instrument Specialties Co., Inc., Little Falls, N. Y.)

by WAYNE MARTIN

Asst. Materials Engr., Sperry Gyroscope Co., Brooklyn, N. Y.

Expanded wartime applications of beryllium-copper have taught materials engineers much about the properties or combinations of properties that are best for individual applications. Significant tests for these qualities have thus been evolved, and in this article Mr. Martin tells what tests to make and how to interpret them in terms of material quality.

—The Editors

BERYLLIUM-COPPER IS STILL in knee pants; as a commercial alloy it has been available only a few years. Yet because of its unusual properties, it has found an important place in the present war effort. As with all new materials, it has taken experience to show just where it should be used, and how it should be handled. Large scale fabrication brought its share of problems too.

Because it combines exceptional strength with corrosion resistance, high endurance strength and heat-hardening after forming, beryllium-copper most nearly approaches the ideal material for springs. It

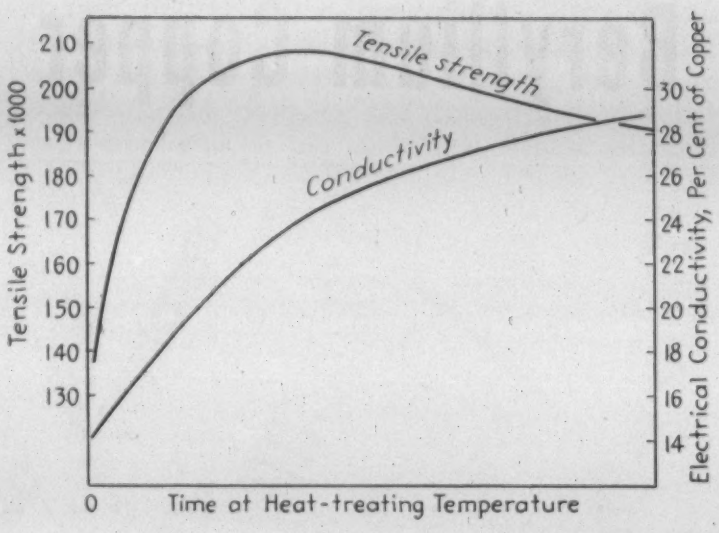


Fig. 1. Changes in tensile strength and conductivity during the hardening heat treatment of beryllium-copper wire for material having acceptable spring properties.

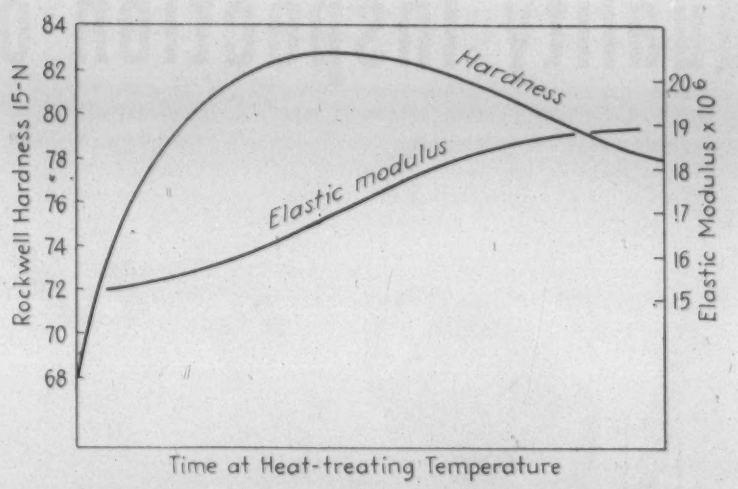


Fig. 2. Hardness and elastic modulus changes during heat treatment provide a measure of quality for strip beryllium-copper.

is in this field that it is making its largest contribution today. Its properties make possible designs that cannot be fabricated with other spring materials. Entirely new products are made possible, and the performance, accuracy and reliability of older equipment is improved. Aircraft instruments, radio equipment, electrical parts, radiosondes, aircraft engine accessories, communication devices, radar instruments and other vital war equipment depend strongly on beryllium-copper springs for vital parts.

New Problems and New Facts

From concentrated experience and the pressure of getting the job done, we have already learned a lot about beryllium-copper and how to handle it. We have learned, for example, that peak properties cannot be obtained by a standardized hardening heat treatment; that cold working has a marked effect on the final properties and the heat treatment required to obtain these properties; that mill processes, particularly the solution heat treatment, have an important effect on final properties; that beryllium content and various alloy additions have a large effect on spring performance.

One other important thing we have learned is that the final heat treatment must be adjusted to bring out the particular properties most needed by the application. Abrasion resistance, endurance strength, proportional limit, stability or freedom from drift, electrical conductivity—any one of these properties can be brought to a maximum, but not all at once.

Forced increase in mill production of beryllium-copper has brought its problems too, and has emphasized the need for a simple test routine to determine before making the beryllium-copper part that the desired final properties will be obtained. In the form of wire and strip as commonly used for springs, these tests are easily and readily made.

Acceptable Wire Quality

For wire, measurement of electrical conductivity and tensile strength will readily predict the performance of any particular lot of material after coiling. Hardness and modulus tests will do the same on strip.

These tests are made by measuring the material as received and as it changes during the hardening heat treatment. On wire for example the electrical conductivity before heat treatment should be no higher than 16 per cent that of copper—the lower the better. Conductivity higher than 16 per cent indicates either the beryllium content too low or incomplete solution heat treatment. During the hardening heat treatment the conductivity will increase, rapidly at first and then at a decreasing rate as shown in Fig. 1, reaching a maximum of 30 to 35 per cent with good material.

Tensile strength of cold drawn wire as received should be within a fairly narrow range. With the proper amount of cold work for highest final spring properties, the tensile should be 130,000 to 140,000 for wire in the size range of 0.030 to 0.090 in diameter. Smaller wire will be a little higher in tensile and larger wire a little lower. If the tensile as received is higher than 150,000 for the 0.030 to 0.090 in. size range, either the solution heat treatment is at fault or the material may have an excess of beta phase present. (More about this later.)

During the hardening heat treatment the tensile strength should rise rapidly to 200,000 or higher, reaching a peak when the conductivity is 24 to 26 per cent or higher as shown in Fig. 1. If the peak is reached while conductivity is lower than this amount, either the beryllium content is low or an excessive amount of gamma precipitate is present at the grain boundaries. If the tensile at the peak value is lower than 200,000 the trouble usually can

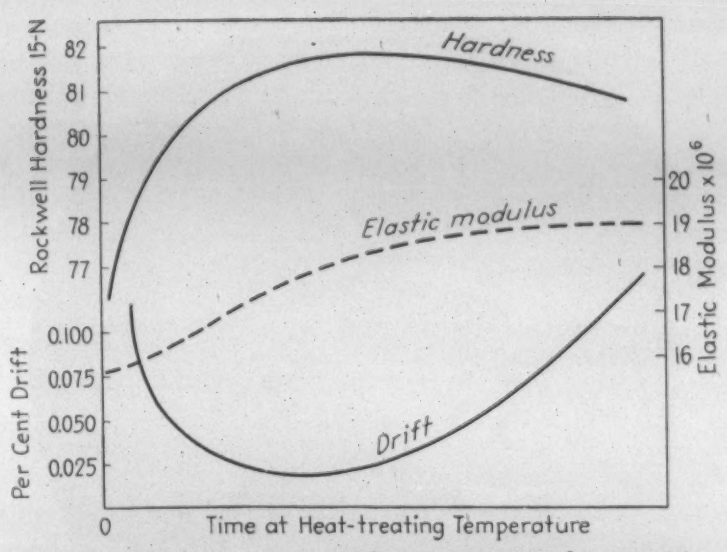


Fig. 3. Drift tests provide an extremely sensitive measure of material quality and also determine the proper heat-treating time and temperature.

be attributed to incomplete solution heat treatment. So much for wire.

Tests for Strip

On strip, the conductivity is not so readily measured, but the elastic modulus change during heat treatment can be used instead. The modulus before heat treatment should be low, not over 15,000,000 and should increase to 18,500,000 to 19,000,000 during hardening as shown in Fig. 2. If the modulus as received is higher, the solution heat treatment was incomplete. A higher modulus and a relatively small change in modulus during hardening definitely indicates poor annealing at the mill.

Hardness measurements on strip give the same story as tensile tests on wire, and the interpretation is exactly the same. Strip material that has been properly annealed and quenched will have a hardness within the following ranges in the condition as received from the mill:

	Brinell Hardness	*Rockwell 15N*
Annealed soft	100	——
2 Nos. hard	185-215	67-69
4 Nos. hard	215-240	69-71

During the hardening heat treatment, the hardness will increase rapidly at first, then slowly, and finally start to fall off, as shown in Fig. 2. Strip cold worked 2 B&S gage numbers should reach a peak hardness of 15N80 to 82. If the maximum obtainable hardness is less, look for incomplete solution heat treatment, low beryllium content or excessive gamma precipitate at the grain boundaries.

Because of the high hardness of heat-treated beryllium-copper and its sensitivity to cold work, the best results are obtained with the Vickers hardness tester or the somewhat less sensitive superficial Rockwell.

All of these tests are readily made on equipment available in most plants and require but little time or specialized experience. On wire for example, a short length can be taken from each coil and a quick check on the conductivity as received will at once tell whether to go ahead with the hardening test. The same specimen then can be given a succession of short heat treatments and an experienced operator can tell from the shape of the conductivity-time curve whether the material is good. Then two or three checks on tensile in the range of 22 to 28 per cent conductivity is all that is needed.

On strip it is best to run the hardness tests first and then to check the modulus if the hardness curve looks satisfactory.

When the material is to be used for springs requiring maximum stability or minimum drift, actual drift tests must be made on specimens heat treated in the range of maximum hardness or tensile as shown in Fig. 3. Such tests will indicate the suitability of the material for the application, but the heat treatment required for the finished spring must necessarily be made on completely fabricated parts because of the effect of cold work introduced in forming or coiling.

Heat Treatment and Structure

Although an understanding of the metallurgy of beryllium-copper is not essential for successful use of the material, examination of the microstructure will often be helpful in finding the cause of failure of springs to perform as expected. Beryllium-copper is a precipitation hardened alloy similar in many respects to the copper-aluminum age-hardening alloys. In fact, the microstructure of beryllium-copper is nearly the same as for the familiar 4½ per cent copper-aluminum.

Beryllium-copper age hardens because the solubility of beryllium in copper is about 2 per cent at 1400 deg. F., while at room temperature less than 0.5 per cent will remain in solution. When rapidly quenched from 1400 deg. F. the beryllium is held in supersaturated solid solution. Following the solution heat treatment the material is cold worked to spring temper and then hardened by heating at a temperature within the range of 600 to 700 deg. F.

Equilibrium is reached by the throwing out of solution of a high beryllium precipitate known as the gamma phase. This precipitate is sub-microscopic in size and causes a keying action on slip planes, resulting in a large increase in strength and hardness. This action also increases the electrical conductivity and elastic modulus. When the heat-treating temperature is sufficiently high, recrystallization of the cold worked structure occurs and internal stresses are relieved resulting in extreme stability or freedom from drift.

Most of the information gained from examination of the microstructure can be obtained from heat-treated specimens. There are in general three things to look for: Grain size, beta phase, and gamma precipitate at the grain boundaries.

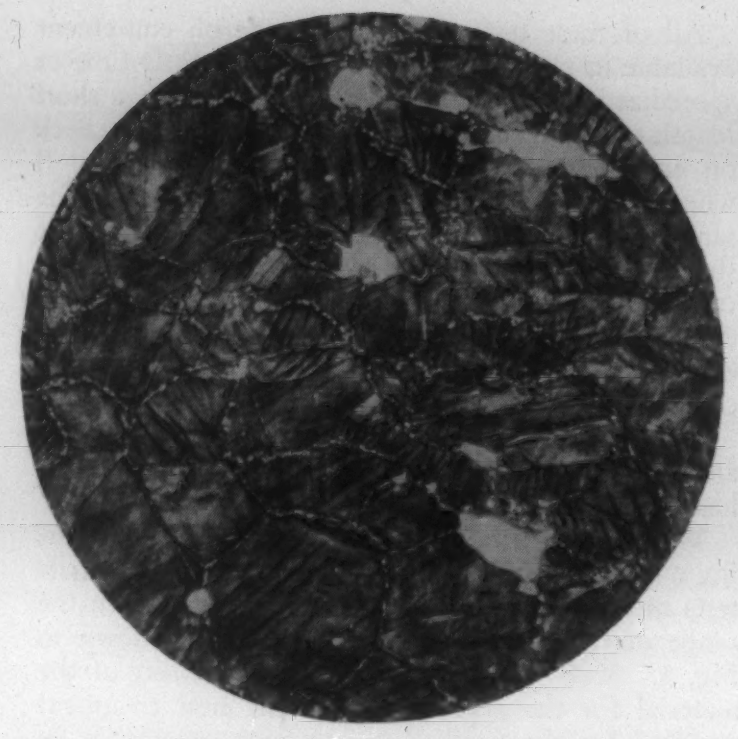


Fig. 4. Microstructure at 500X for a material having the desired grain size and but little grain boundary precipitate. The hard beta phase (white) is present in a quantity indicating a beryllium content of about 2.1 per cent.

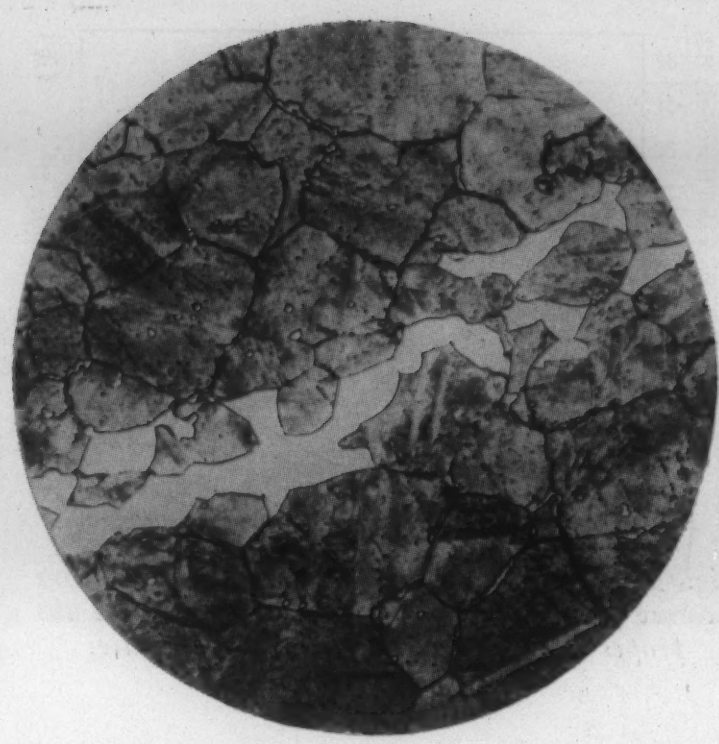


Fig. 5. Long stringers of beta phase when present cause excessive die wear, distortion during hardening heat treatment, and represents beryllium present but unavailable for hardening.

Fig. 6. An excessive amount of beryllium when present in the gamma phase at the grain boundaries reduces the amount of beryllium available for hardening, and causes distortion in hardening.

Grain size is useful in indicating the temperature at which the solution heat treatment was carried out. Best properties are usually associated with relatively fine grain size of the order of 0.02 to 0.04 mm. in the case of material containing iron, nickel, or cobalt as a grain refiner, as shown in Fig. 4. A grain size as small as 0.005 mm. indicates that the temperature required for complete solution of the beryllium was never reached. A grain size of 0.05 mm. or larger, resulting from a high temperature anneal will quite often be found in materials showing more than the usual tendency to distort during the hardening heat treatment.

Beta phase particles are readily observed as irregular white patches or long stringers and offer a ready approximation of beryllium content. The presence of a few small irregular particles usually accompanies a beryllium content of 1.9 to 2.0 per cent with the size and number of particles increasing rapidly with every 0.1 per cent increase in beryllium content.

Long stringers of the hard beta phase shown in Fig. 5 are the result of segregation in the billet or ingot as cast and invariably cause serious difficulty in fabricating springs of the material. Because of differences in modulus, hardness and volume change during hardening, beta stringers cause difficulty in cold work and are sources of weakness in the metal.

Gamma precipitate at the grain boundaries shown in Fig. 6 is caused by slow heating in batch annealing. This results from the tendency of the beryllium to migrate to the grain boundaries when the temperature is too low for it to dissolve in the copper.

With excessive grain boundary precipitate, the chemical analysis may show a satisfactory beryllium content, but the physical properties will be characteristic or an alloy having low beryllium content. This, of course, is the direct result of insufficient beryllium available within the grain to produce the necessary slip plane keying upon which the high physical properties depend. An expansion accompanies gamma precipitation and, if it is not uniform, distortion results. Annealed soft metal is partcularly susceptible in this respect.

Mill-Processing Effects

It is apparent, therefore, that the conditions surrounding the solution heat treatment in the mill have a large effect on the results that can be obtained from the hardening heat treatment. For best final spring properties, the solution temperature should be reached rapidly to avoid gamma at the grain boundaries; the solution temperature should only be high enough to cause recrystallization and grain growth to about 0.04 mm.; the quench should be sufficiently rapid to prevent any gamma precipitation evidenced by low conductivity and low modulus.

In addition, the mill reduction of the billets must break up beta constituent uniformly throughout the metal as alpha solid solution. If the mill conditions are correct, and if the proper hardening heat-treatment is determined for the material received, then all of the expected advantages of beryllium-copper can be obtained—uniformly, lot after lot.

Only a little experience with the hardness, tensile and drift tests outlined earlier in this article will show the advantages of using a higher hardening temperature (with a corresponding shorter time) than usually specified. High temperature short-time heating not only cuts heat-treating costs and production delays, but gives higher physical properties, better electrical conductivity, better control over distortion, more complete stress relief, and much lower drift. If beryllium-copper is required, it should be heat-treated to its best properties.

For each of these "micro-processed" beryllium-copper springs, incoming material is checked for quality by methods outlined in this article, and each production lot heat-treated for best spring properties using a high temperature, short-time heat treatment. (Courtesy: Instrument Specialties Co., Inc.)

(Editorials continued from page 1177)

all, industry is merely going through eras that society in general has already witnessed in the coming of woman suffrage, placing of women in Government, etc.

Meanwhile, the 75 per cent, say, who return to their homes will carry benefits of their industrial experience there. They will insist on kitchen sinks at the correct height (perhaps adjustable sinks), proper light, mechanical garbage disposal, etc. And — perhaps the women will repair their own leaky faucets and broken electric fixtures, not to mention punctured tires. —H. A. K.

Navy Swap

In our February issue we were pleased to announce that a new associate editor, Robert S. Burpo, Jr., had been added to our staff specifically to prepare reference data and articles on materials and processes. Mr. Burpo had scarcely joined us when the Navy filed a dormant claim upon him, and he entered Fort Schuyler for indoctrination April 1st.

In the few months he was completely a part of METALS AND ALLOYS, Mr. Burpo was able to establish the new "Engineering File Facts" department in an immediately popular form and with exactly the kind of collated material currently needed by materials and process engineers.

To continue this service we have appointed a new engineering editor to the staff — Kenneth Rose, an inspector with the Navy Bureau of Ordnance until recently released to improve his contribution to the war effort. Mr. Rose, a graduate of West Virginia University, has a long record of both journalistic and engineering experience, having been employed by A. B. Farquhar Co., York, Pa.; Gazette Publishing Co., York; P. H. Glatfelter Co., Spring Grove, Pa.; and Gannett, Eastman & Fleming, Harrisburg, prior to his ordnance work with the Navy.

Harold Knight officially assumes the title and function of news editor and, among other things, will be specially responsible for staff work on post-war plans, materials and processes. —The Editors

Record Attendance at Conventions

An outstanding feature of recent technical society conventions this year, particularly in the metal field, has been the large attendance. Under conditions when a reduced assemblage for obvious reasons would justifiably be expected, the totals in several cases have exceeded pre-convention expectations and have made new records.

At the February meeting of the A.I.M.E. not only was the total of those registering and attending the sessions of the metal divisions a record, but so also was the registration for the Institute as a whole. No larger registration was ever recorded for a non-exhibition gathering of the A.F.A. than the 1943 convention in St. Louis in April — the program consisted entirely of technical and practical papers and discussions. And during the same days when the foundrymen were in session, the open-hearth and blast furnace men of the country gathered in Cleveland and rang up a total attendance exceeding any previous meeting — nearly 840.

There are several possible explanations of this trend. Among these may be mentioned the decided eagerness of such men to learn at first hand just what is going on in these strenuous days; hence attendance at such gatherings is of prime importance. Listening to papers and discussions and especially personal contact with others in one's special sphere of activity are highly beneficial. Then too it must be recalled that most of these men are active in war production where they work long hours and under great strain. Hence managements look with favor on such opportunities for much-needed change of scene and relaxation.

After the war is over and discussion of the many metallurgical and engineering developments in war production is given free rein, there will at least be little slackening in this trend. —E. F. C.

Machine-Finish Allowances for Castings

This table and the explanatory remarks below are presented to aid designers and foundry engineers in determining the amount of extra metal that must be provided to allow for subsequent machining, according to the size and material of a casting. These data should be studied in conjunction with the article by Mr. Hindle that is concluded in the feature section of this issue.
—The Editors

Metal	Pattern Size, In.	Bore, In.	Finish, In.
Cast Iron	Up to 12	1/8	3/32
	13 to 24	3/16	1/8
	25 to 42	1/4	3/16
	43 to 60	5/16	1/4
	61 to 80	3/8	5/16
	81 to 120	7/16	3/8
	Over 120	special instructions	
Steel Castings[1]	Up to 12	3/16	1/8
	13 to 24	1/4	3/16
	25 to 42	5/16	5/16
	43 to 60	3/8	3/8
	61 to 80	1/2	7/16
	81 to 120	5/8	1/2
	Over 120	special instructions	
Malleable Iron[2,3,4,5]	Up to 6	1/16	1/16
	6 to 9	3/32	1/16
	9 to 12	3/32	3/32
	12 to 24	5/32	1/8
	24 to 35	3/16	3/16
	Over 36	special instructions	
Brass, Bronze and Aluminum Alloy Castings[6]	Up to 12	3/32	1/16
	13 to 24	3/16	1/8
	25 to 36	3/16	5/32
	Over 36	special instructions	

Remarks and Interpretations

[1] Allowance ranges from 1/8 to 1 in. Values given for finish are normal for ordinary finishes on the drag side, or on vertical surfaces where distortion is an unlikely factor. *If necessary to have finished surfaces on the cope side of the castings, it not infrequently is necessary to double the finish allowance.*

[2] When castings are constructed so that they warp more than the average amount, the allowances given should be increased.

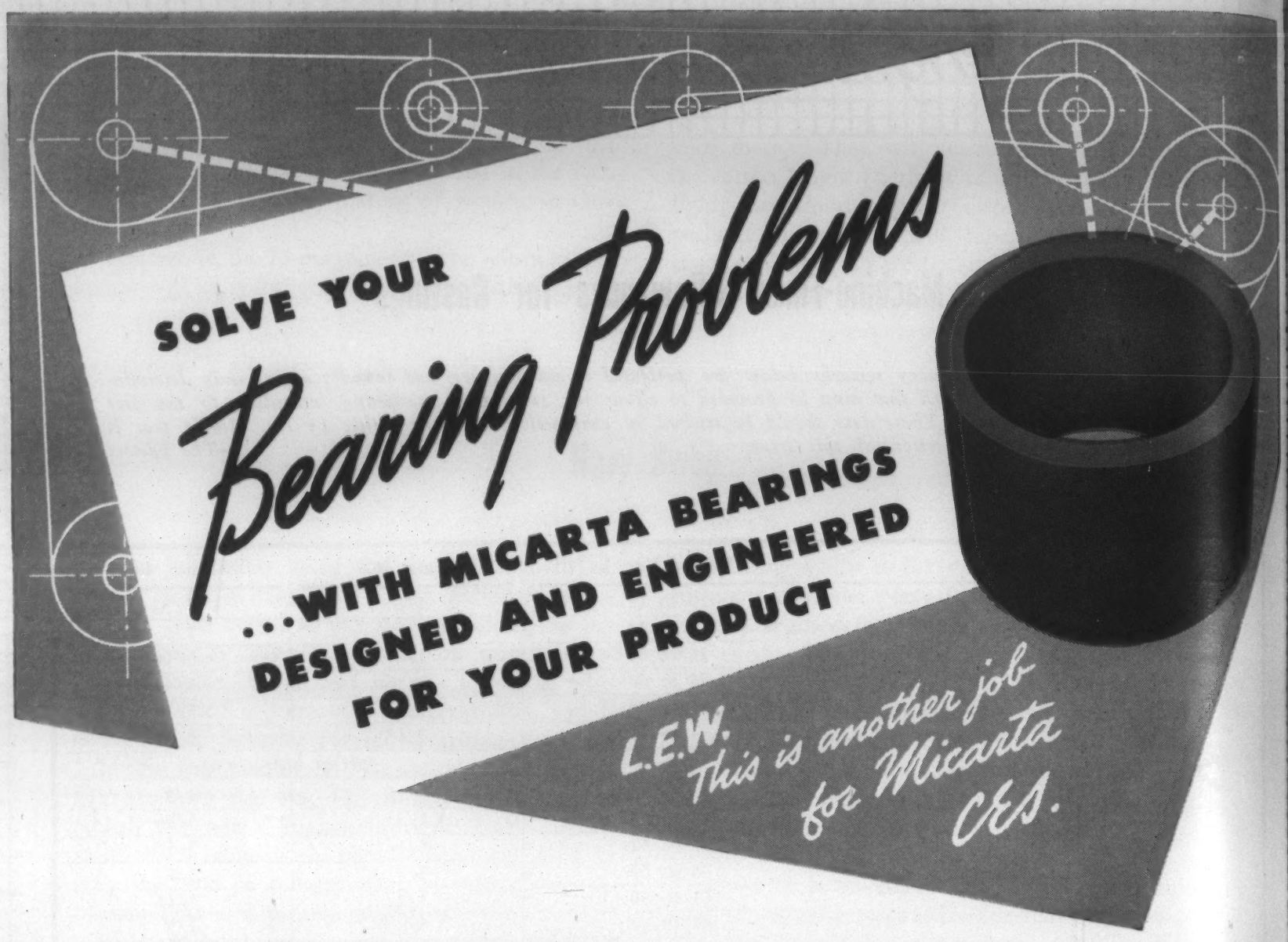
[3] Disk grinding — only sufficient finish required to take care of draft and possible warpage.

[4] Coin pressing — practically no finish allowance required. As the properties of malleable iron particularly lend themselves to this method of finishing, it should be employed to a much greater degree than it is.

[5] For small parts, an allowance of from 1/32 to 1/16 in. is satisfactory. Larger parts require a slightly greater allowance. The allowance necessary depends on (a) whether the part is to be made in sufficiently large quantities to justify the making of straightening dies, (b) the fact that many finishing operations on malleable castings can be performed in a coining press, which practically eliminates finish allowance in the case of those particular operations, and (c) the further fact that many disk grinding operations are performed on malleable castings, for which only a few thousandths finish is required.

[6] For small medium-sized non-ferrous castings, 1/8 in. is a customary allowance, with correspondingly larger allowances on larger castings. On split railway motor-bearings the allowance is about 1/64 in. at the parting for a grinding operation and 3/32 in. each on the outside and inside diameter on a side for machining.

Compiled by N. F. Hindle
Asst. Sec'y., American Foundrymen's Ass'n.



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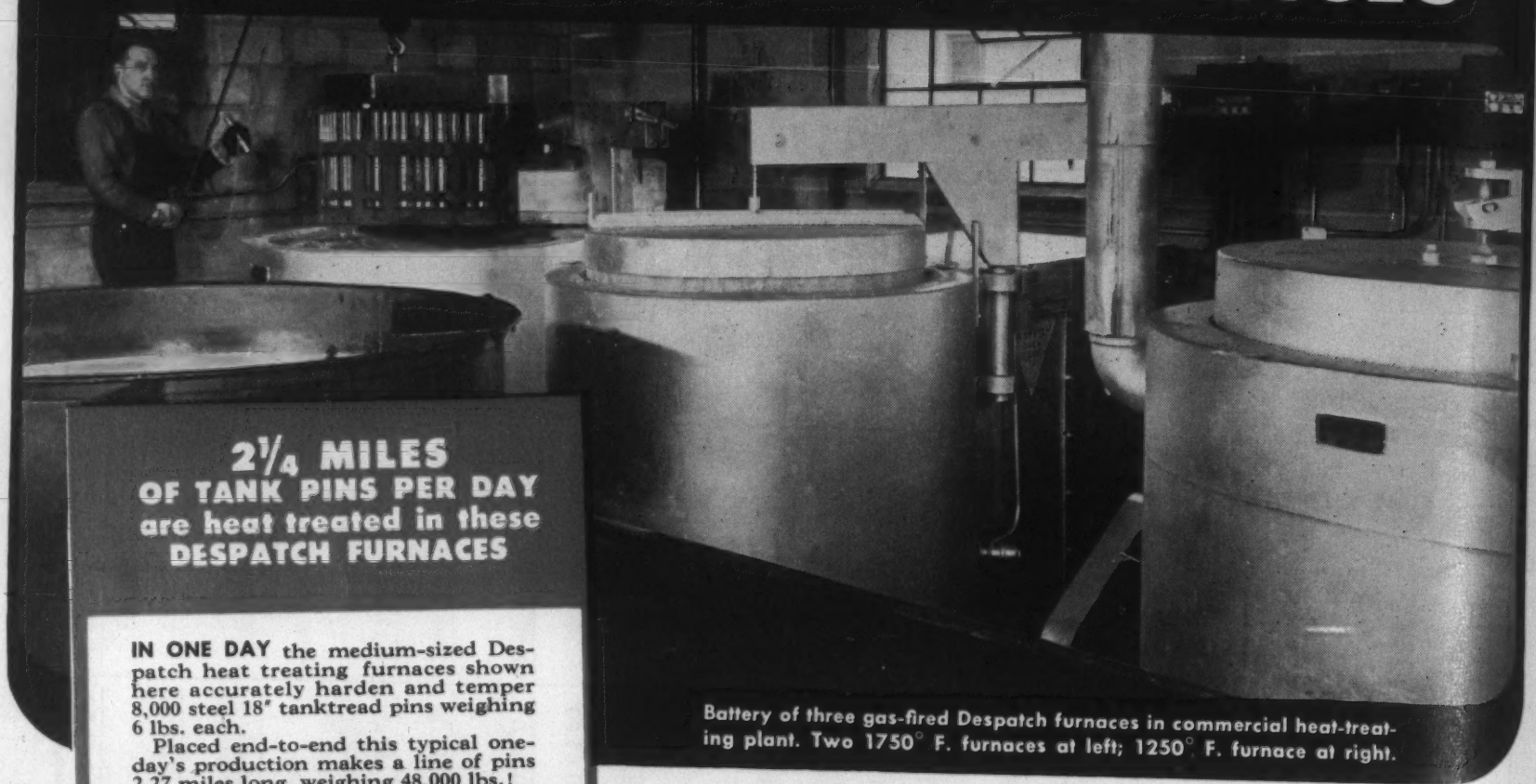
A Digest of Common Specifications

Compiled by Robert S. Burpo, Jr.

Name	Characteristics	Specifications	Form or Grade	Composition, Per Cent					
				Cu	Pb	Fe (max.)	Zn	Sn	Others
Leaded red brass (hardware bronze)	Has excellent cutting qualities; corrosion resistance is about the same as that of copper	ASTM B140, Type A	Leaded red brass (hardware bronze) rods, bars and shapes	83.50-86.50	1.50-2.25	0.10	Remainder	—	0.50 max.
		ASTM B140, Type B	"	87.50-90.50	1.25-2.25	0.10	"	—	0.50 max.
		ASTM B121, Alloy #1	Leaded brass sheet and strip	89.00-91.00	0.35-0.65	0.10	"	—	—
Lancashire brass	Shears and punches well, leaving clean, smooth edges	ASTM B146, Alloy #6A	Leaded yellow brass sand castings for general purposes	70.00-73.75	2.50-3.50	0.60	"	0.75-1.50	0.87 max.
		ASTM B30, Alloy #6A	Copper-base alloys in ingot form for sand castings	70.00-71.75	2.50-3.50	0.50	"	0.75-1.50	0.96 max.
Leaded high brass	Has excellent deep drawing, stamping and cold working properties; machinability is good	ASTM B121, Alloy #7	Leaded brass sheet and strip	65.50-68.50	3.50-4.50	0.10	"	—	—
		ASTM B135, Alloy #4	Miscl. brass tubes	65.0-68.0	1.25-2.00	0.07	"	—	—
		ASTM B30, Alloy #6B	Copper-base alloys in ingot form for sand castings	65.0-67.50	2.75-3.50	0.50	"	0.75-1.25	0.96 max.
		ASTM B121, Alloy #2	Leaded brass sheet and strip	63.00-67.00	0.20-0.70	0.10	"	—	—
		ASTM B121, Alloy #3	"	63.00-67.00	0.70-1.10	0.10	"	—	—
		ASTM B121, Alloy #6	"	62.50-65.50	2.00-3.00	0.10	"	—	—
		ASTM B146, Alloy #6B	Leaded yellow brass sand castings for general purposes	64.00-69.00	2.50-3.50	0.75	"	0.50-1.25	—
		SAE 41	Yellow brass castings	62.00-67.00	1.50-3.50	0.75	"	1.00 max.	0.93 max.
Engraver's brass	Combination of good machining and forming qualities.	ASTM B121, Alloy #4	Leaded brass sheet and strip	61.00-64.00	1.25-2.00	0.10	"	—	—
		ASTM B121, Alloy #5	"	61.00-65.00	1.50-2.50	0.10	"	—	—
Free-cutting brass rod	This is the most important of all leaded brasses; parts are usually made by hot extruding or cold drawing to size as the material has excellent plasticity between 1200 and 1450° F. and can be readily extruded into intricate shapes; the rod machines best when in the hard condition; it cannot be forged or hot rolled	ASTM B16	Free-cutting brass rod for use in screw machines	60.0-63.0	2.50-3.75	0.15	"	—	0.50 max.
		SAE 72	Free-cutting brass rod	60.00-63.00	2.50-3.75	0.15	"	—	0.50 max.
		ASTM B121, Grade C	Naval brass rods, bars and shapes	59.0 -62.0	1.25-2.25	0.10	"	0.5-1.0	0.10 max.
		ASTM B30, Alloy #6C	Copper-base alloys in ingot form for sand castings	58.00-61.00	0.75-1.25	0.50	"	0.75-1.25	A1:0.10-0.20
		ASTM B124, Alloy #2	Copper-base alloy forging rods, bars and shapes	58.00-62.00	1.50-2.50	0.30	"	—	0.35 max.
		ASTM B146, Alloy #6C	Leaded yellow brass sand castings for general purposes	58.00-62.00	0.75-1.50	0.75	"	0.50-1.25	1.05 max.
		SAE 88	Brass rod	58.50-61.50	1.50-2.50	0.15	"	0.15 max.	0.25 max.

HEAT TREATING?

PRODUCE more today... PROFIT more tomorrow... WITH DESPATCH FURNACES



Battery of three gas-fired Despatch furnaces in commercial heat-treating plant. Two 1750° F. furnaces at left; 1250° F. furnace at right.

2¼ MILES OF TANK PINS PER DAY are heat treated in these DESPATCH FURNACES

IN ONE DAY the medium-sized Despatch heat treating furnaces shown here accurately harden and temper 8,000 steel 18" tanktread pins weighing 6 lbs. each.

Placed end-to-end this typical one-day's production makes a line of pins 2.27 miles long, weighing 48,000 lbs.!

Each Pin Held Separately

Special alloy steel fixtures accommodate 294 pins at a time. Each pin is held vertically, separated from the others, and with ample space above and below. This allows very uniform heating, faster and more even quenching, and minimizes distortion.

Hardened in Twin 1750°F. Furnaces

Hardening is done in the two Despatch 1750° F.-type furnaces at the left. Each is of medium size (inside dimensions 35" diameter by 28" deep). Furnaces are gas-fired, have completely automatic controls and recorders.

At present, tank-pins are hardened about 105 minutes at 1550° F., then fast-quenched for 12 minutes at 180° F. in circulating 1000 g. p. m. oil quench, which has a system capacity of 2500 gallons.

Tempering is done in third Despatch furnace (1250° F. type) at extreme right for 60 minutes at 1050° F., then air-cooled.

Reduces Distortion by 93%

Before Despatch furnaces were installed, distortion ran as high as .090" to .110". Now distortion has been reduced to less than .008". Because toughness is specially sought in tank-pins, Rockwell "C" readings run between 35 and 37.

Why heat-treaters get more use from Despatch Furnaces

Accurate wide-range operation is an extra performance advantage which commercial heat-treaters appreciate in Despatch furnaces. They should, too, because this flexibility means greater all-around utility . . . capacity for handling more jobs per furnace . . . increased profits from production.

Above is part of a progressive commercial heat-treating shop showing a typical set-up of two Despatch 1750° F. furnaces and one Despatch 1250° F. furnace. These run 24 hours a day, heat-treating *anything* within their heat range.

They're always kept busy and turn out more uniform work than any other furnaces in the entire plant. In fact, their processed-to-specifications output is such that the shop is now able to handle many *additional* heat-treating contracts — something never possible before.

IMPROVE YOUR PRODUCTION and increase your shop's heat-treating capacity with Despatch furnaces. Write today for illustrated Bulletin 81-E.

DESPATCH OVEN COMPANY MINNEAPOLIS

Hardness Tests

A brief, general discussion of hardness testing appears on page 1219

Table I.—Comparison of the Important Characteristics of Common Hardness Testing Instruments

Name of Instrument	Principle of Operation (Type of Penetrator, Major Load, Etc.)	Testing Techniques (Preparation of Surface to Be Tested, Procedures, Etc.)	Approximate Depth of Penetration** In Inches	Remarks (Fields of Usefulness, Etc.)
Scleroscope (Scl)	Diamond tipped weight falls from a standard height; the height of rebound is the measure of the hardness.	Surface to be tested must be clean, polished metal; the instrument must be clean (so that the weight can fall and rebound freely) and must be in a vertical position, simple to operate (scale or dial is direct reading).	None	Portable and can be used to check large parts that cannot be moved or handled easily. Readings are not always consistent or reproducible, making comparisons with other hardness values uncertain. Hollow parts and thin sheet stock give incorrect values.
Brinell (BHN)	Hard steel ball (10 mm. dia.) is pressed with a standard force (3000 Kg-Wt) into the surface to be tested; the dia. of the impression is the measure of the hardness.	Surface to be tested must be clean metal. Simple to operate; care must be exercised measuring (with microscope) dia. of impression; this dia. must be converted to BHN using tables or formula.	0.006-0.019	A reliable instrument in the soft to medium-hard range; above 600 BHN the ball deforms permanently, destroying its accuracy. Used with such materials as C.I. and bronze where an average hardness is desired (a diamond point might indicate "grain hardness").
Brinell	Same as above except the load is 500 Kg-Wt.	Same	0.001-0.003	Used for the softer metals and alloys, such as brass, aluminum, etc.
Rockwell	A penetrator is impressed into the surface to be tested; a standard force is used and the depth of penetration is the measure of the hardness. (For more detailed listing of the different penetrators and their uses, see Table II.)	A scale-free surface that is fairly smooth permits accurate testing. Rockwell testers are simple to operate and have a direct reading dial. The work to be tested must be firmly supported.	(See Table II)	With the various penetrators and changes in load, the Rockwell instrument is adaptable to a wide range of hardness tests. Parts having a radius of curvature less than 3/16" are liable to give inaccurate readings.
Monotron (M-1)	A small diamond ball 0.030" dia. is forced a standard distance (9 scale divisions or 0.0018") into the part to be tested; the force necessary to do this is the measure of the hardness.	Samples with either a clean or a rough and scaly surface may be checked; a slightly different technique is used in each case. The instrument is direct reading and requires a bit more care in operating than the Rockwell machine.	0.0018	Can be used with very thin samples and with case-hardened steels; materials ranging in hardness from very soft to very hard (such as nitrided surfaces and cemented carbides) can be checked without altering the instrument.
Vickers (DPH)	The principle is the same as that of the Brinell tester: A 136° diamond pyramid of square cross-section is forced into the sample; the ratio of the load to the area of the resulting impression is a measure of hardness.	The surface to be tested must be carefully prepared as the impressions are small and care must be exercised in the use of this instrument. The machine is simple to operate; the measurements of the diagonals of the impression require some precision.	0.00076-0.0038	The DPH numbers are practically constant irrespective of the load used; although 50 and 10 Kg. are the common values, the available range is 1-120 Kg. This instrument is the most accurate of all and can be used over the entire range of hardness.

***. When two values are given, the first pertains to hard materials and the second to the softer materials as tested on the particular instrument.*

(Continued on page 1219)

Don't look for "SWEAT"

WHEN YOU HEAT-TREAT MOLY HIGH-SPEED STEELS

It is a general rule that the best quenching temperature for a piece of high-tungsten high-speed steel is the "sweating" temperature. Heat-treaters simply wait for the bubbles of fused oxide to form on the surface of the steel, then pull it out of the furnace and quench it.

This method will not work for high-molybdenum high-speed steel. The reason is simple. The best quenching temperature for high-moly is reached *before the steel begins to sweat.* If you heat high-moly up to "sweating" temperature, you'll coarsen the grain and fuse carbides inside the steel, ruining its cutting properties.

Here are some specific suggestions to heat-treaters who are working with molybdenum high-speed steel:

1. Heat-treat the steel in a controlled-atmosphere furnace, if possible.

2. If no such furnace is available, protect the steel against oxidation by coating it with borax while in the furnace.

3. Quench a moly high-speed steel at a lower temperature than you would quench an 18-4-1 or 18-4-2 grade. For example, we recommend that our Bethlehem 66 Moly steel be quenched between 2225 deg. and 2275 deg. F. Bethlehem HM High Speed should be quenched in this same temperature range. (These temperatures are 75 to 100 degrees lower than quenching temperatures recommended for Bethlehem high-tungsten high-speed steels.)

4. If you have any doubts about proper treatment of any Bethlehem tool steel, let us know. We maintain a staff of engineers who are specially skilled in solving such problems. Their services are at your call.

BETHLEHEM STEEL

Engineering File Facts

Hardness is a difficult term to define for it "is distinctly a characteristic of the test (method) used."[1] As may be seen from Table I, most of the common production or commercial types of hardness testers are instruments that measure either resistance to penetration or to deformation. That is, most of these testers make use of an indentor or penetrator that either deforms (as a spherical indentor) or penetrates (as a diamond point) the surface of the material to be tested.

There are, of course, other types of hardness testers (such as Knoop, microhardness, microcharacter, Herbert pendulum and dynamic instruments), but these are mostly for specialized or laboratory use and, therefore, are not included in Table I.

In general, the sample must have a thickness of ten times the depth of penetration of the indentor to avoid errors due to "anvil effect"; in some cases (such as the scleroscope and Brinell, 3000 Kg) the test piece must be at least ¼ in. thick for accuracy.

Hardness measurements and conversion relations between various hardness scales vary with the type of material being tested. Hardness conversion tables for various materials are given by Scott and Gray.[2] Tables for cartridge brass appear in "A.S.T.M. Standards," 1942, Part I, p. 926.

[1] *Ridgway, Ballard & Bailey, Trans. Electrochemical Soc., Vol. 63 (1933); see also S. L. Hoyt, Trans. ASM, Vol. 28, No. 2, p. 421.*

[2] *Howard Scott & T. H. Gray, Trans. ASM, Vol. 28, No. 2, p. 409.*

Table II.—A Listing of the Various Rockwell Hardness Testing Scales and Their Uses

Scale Designation	Type of Penetrator	Major Load, Kg.	Approx. Depth of Penetration, in Inches	Remarks (Fields of Usefulness, Etc.)
Ra	120° diamond cone or "brale"	60	0.0010-0.0029	Used for testing very hard materials (such as tungsten carbide) where the heavier load of the C scale might cause the diamond brale to chip; also used for thin hard materials like razor blade stock.
Rb	1/16" dia. ball	100	Approx. 0.00008" penetration per "point" of hardness	For checking the hardness of rolled sheet and strip brass (sheets as thin as 0.020") and annealed low and medium carbon steels. The effective range is 0-100 Rb; at the higher hardnesses the ball is not so sensitive to small changes as is the brale.
Rc	Brale	150	0.0026-0.007	The standard scale for metals and alloys harder than Rb 100; its useful range is Rc 20-70.
Rd	Brale	100	0.0017-0.0048	Used when a lighter load than that of the C scale is desired; sometimes used on case-hardened parts.
Re	1/8" dia. ball	100		For the very soft materials such as bearing alloys.
Rf	1/16" dia. ball	60		About the same range as the E scale; used for some annealed brass sheet and strip 0.020" thick and over.
Rg	1/16" dia. ball	150		For some of the harder wrought copper alloys (such as phosphor bronze sheet) and for metals harder than those tested with the B scale.
Rh	1/8" dia. ball	60		These have certain specialized uses with very soft materials.
Rk	1/8" dia. ball	150		
Rl	1/4" dia. ball	60		
Rm	1/4" dia. ball	100		
Rp	1/4" dia. ball	150		
Rr	1/2" dia. ball	60		
Rs	1/2" dia. ball	100		
Rv	1/2" dia. ball	150		
15-N	Brale	15	Approx. 0.00004" penetration per "point" of hardness	For thin sheet stock, case hardened steels and finished parts where the indentation must be kept to a minimum.
30-N	Brale	30		
45-N	Brale	45		
15-T	1/16" dia. ball	15		Similar scales to 15-N, 30-N and 45-N except that a 1/16" dia. steel ball is used. (Used for 0.012" and thicked rolled sheet and strip copper alloys.)
30-T	1/16" dia. ball	30		
45-T	1/16" dia. ball	45		
W	1/8" dia. ball			For special work — very soft metals and alloys and non-metallic materials.
X	1/4" dia. ball			
Z	1/2" dia. ball			

Compiled by Robert S. Burpo, Jr.

THIS is no time to "put up with" bygone methods of cutting metals—not when you can breeze through bars, rods, tubes as easily as slicing tomatoes. A RADIAC Cut-Off Machine, equipped with a RADIAC Cut-Off Disc (the ideal cutting combination, you know), will whisk off a round of cold-rolled steel in 2 1/5 seconds —one stroke and it's done—and make a cut so true and smooth and clean that finishing is unnecessary for most purposes. There's no burning or bluing either, for RADIAC cuts cool, well below the carbonization point. It's the same for bronze, molybdenum, plastics, and many other materials. So if you have any reasonable quantity of stock to cut, don't waste time and material with old-fashioned methods —do the job better and faster with RADIAC. Write today for complete information on the 7 types of RADIAC Cut-Off Machines, to Machine Sales Division, 106 S. 16th Street, Philadelphia, Pa.

TYPE K—Wet and Dry Cutting

RADIAC* **CUT-OFF MACHINES**

*T. M. Reg. U. S. Pat. Off.

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Manufacturers of RADIAC and POR-OS-WAY Grinding Wheels

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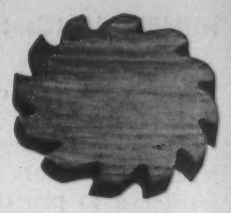
CHECK THESE CUTTING TIMES



HIGH SPEED STEEL
1" Round
2 1/5 seconds

ROLLER BEARING STOCK
1 5/16" O. D.
2 1/2 seconds

UNNEALED STAINLESS STEEL
1" Square
2 1/2 seconds

CHROME MOLYBDENUM
1 1/2" O. D.
1 1/2 seconds

TOBIN BRONZE
1 1/2" Round
2 4/5 seconds

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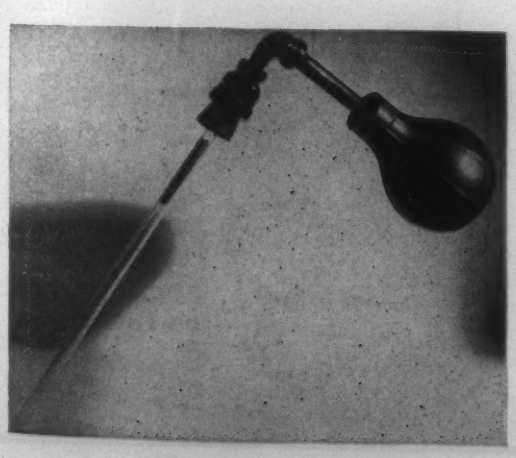
METALLURGICAL ENGINEERING shop notes

Sampling for Spectrographic Analysis

by H. H. Simmons,
Crane Company

Here is a novel and ingenious method for securing a representative sample from furnace, ladle or riser for spectrographic analysis. The device is simple, consisting basically of a glass tube, with syringe bulb at the end. Like filling a fountain pen, the tube end is inserted into the molten liquid, the bulb released, and the apparatus withdrawn. Upon cooling, the glass cracks off, leaving a clean metal rod, the spectrographic electrode.

The method was developed by the Crane Co., Chicago, and consists of a glass tube, 8 in. long, ¼ in. I.D., in-



serted in a rubber stopper. The stopper, in turn, is fitted into an elbow fitting on the end of a metal ⅛ in. pipe. A rubber bulb is on the other end of the pipe, the length of pipe depending on the accessibility of the sample. A small wad of steel wool is pushed into the glass tube near the stopper to prevent the metal from being drawn into the pipe.

In the operation the bulb is compressed, the end of the tube dipped into the molten metal, the bulb released and the tube removed. All is done in a single motion, for the glass tube melts rapidly. After the glass has cracked off, leaving a clean metal rod, the rod is cut into two pieces, the ends ground and polished to the correct shape for spectrographic electrodes.

The accompanying photograph, courtesy Crane Research Laboratories, shows the apparatus ready to insert into the melted metal.

Shrinking Over-Expanded Rings

by Wm. Boyle & Arne Yitti,
Lindberg Engineering Co.

Often interior diameters of circular metal parts, doughnut-shaped, have expanded in service and need to be shrunk to become useful again. Such shrinking can be accomplished by several simple methods.

As an example, a water-hardening draw ring was .015 in. oversize on the inside diameter. In shrinking, it was brought back .035 in., which left enough stock to permit accurate grinding to size. Shrinking equipment consisted of a flat board covered with asbestos paper and two handles, a foot or so high. The ring was heated thoroughly to 1500 deg. F. in a neutral or oxidizing atmosphere, then placed on the asbestos of the board, burning into it for 5 sec. to effect a tight seal.

All was now submerged in brine to within ¼ in. of the top before it cooled below its critical point, guarding against brine flowing over the ring's top. It was so held until the ring's inside became black, when it was submerged completely.

The brine's cooling action on the ring's outside made that surface shrink, the ensuing pressure causing the steel to upset at the inner diameter, which was still hot. Thereafter, the ring was annealed, sandblasted, rehardened and ground to size. Shrinking can be repeated two or three times during the life of the ring.

Another shrinking method was employed with a carburized spur gear, which opened up .005 in. in hardening. With a torch, heat was applied to the inner diameter of the hardened part. The outside, under tension from hardening, relieved itself, thereby upsetting the metal at the inner diameter. This method is useful for reductions of .005 to .006 in.

Full annealing is a third method to shrink spur gears, by which they are shrunk as much as .010 in. After the full anneal, to prevent the gear from opening up again with conventional hardening, the teeth can be hardened by spinning the gear in a lead pot.

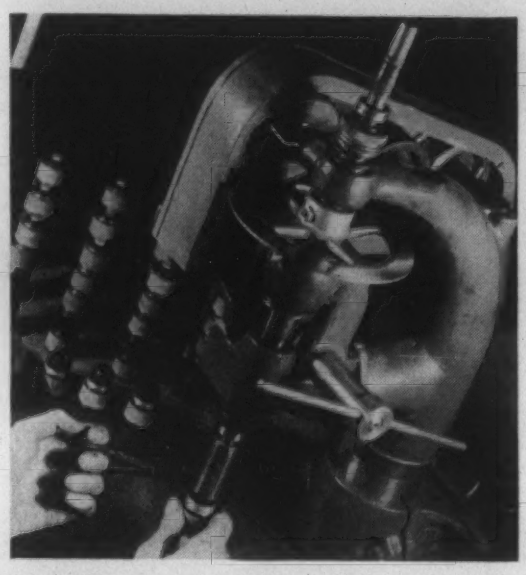
Sometimes, when gears have opened up only .001 to .002 in. in hardening, a temper four to five times longer than normal will reduce the bore to its prescribed tolerance.

"When I first ventured to weld aluminum with the arc, I encountered slag pockets, spatter, etc.," states Arnold E. De Ornellas, of British Guiana. "Upon receiving a fresh shipment of rods, I discovered that if these are not kept properly when the packet is opened, climatic reactions penetrate the high quality of the coating, which deteriorates the alumina, resulting in a very poor weld."

Lapping Aluminum Threads

by Victor S. Voight,
Westinghouse Electric & Mfg. Co.

In delicate lapping operations on female threads in aluminum parts, the problem is to avoid applying excessive pressure and destroying the soft threads. This has been solved at the Mansfield,



Ohio plant of the Westinghouse Electric & Mfg. Co., where a standard tapping machine is used.

While the lapping compound is applied by a brush with the left hand, the part is firmly held against the lap, which is mounted on the end of the tapping machine spindle. Threads are lapped to the proper fit by passing the female threads up and down over the male threads on the lap by utilizing forward and reverse speed of the machine spindle.

One usually thinks of hard facing at a working edge. Thus, with an ordinary shovel the edge that first enters the pile would seem to be the logical spot for resurfacing. Yet the maximum bulge on the bottom (each face of the heel) is a practical place to reinforce because of constant scraping against cement floors, etc. The life of the scoop shovel can be increased 4 to 6 times by hard-facing with Haynes stellite rod. Two bands on each face (4 in total) are deposited, each 4 or 5 in. long, 1/8 in. thick and 1 in. apart. It takes 10 min. to do and requires 12 in. of 1/4-in. rod.

—"Oxy-Acetylene Tips," Linde Air Products Co.

Heat Treating Aluminum Bronzes

by George P. Halliwell,
H. Kramer & Co.

Aluminum bronzes are similar to steel in their methods of heat treatment and in the resulting changes of microstructure and mechanical properties. Used in the foundry, they are essentially alloys of copper and aluminum, with smaller amounts of iron, nickel, silicon and manganese, added singly or in combination. Only those alloys containing between 9.5 and 11.5 per cent aluminum are appreciably susceptible to heat-treatment, with the most marked improvement in properties between 9.75 and 10.75.

The bronzes are heated to 1450-1700 deg. F., holding long enough to permit homogenization of the cast structure. Then comes quenching in water or oil. To age, it is heated to some temperature up to 1200 deg. F., holding, then cooling in air, water or oil. Time periods and temperatures depend on composition, properties desired, size, shape and cross-section thickness of the casting.

The lower the aluminum content, the higher the solution temperature and the longer time needed for any one casting, modified by amounts of other alloying elements. The lower the aging temperature, the higher will be the hardness, tensile and yield strengths, and the lower the elongation.

An increase in aging time results in an initial increase in tensile strength and elongation, and a slight drop in yield strength and hardness, followed by gradual drop in all properties with continued time. Aging below the critical temperatures always means lower elongations.

Hand file reconditioning adds about 60 per cent to the original life of the file, according to questionnaires sent to shopmen of leading ordnance and industrial plants. Cost of reprocessing is only from one-half to one-third the cost of a new file. It is indicated that 600 tons of high carbon steel can be conserved, as well as savings in man-hours.

—Tool Div. of the Conservation Div., War Production Board

Centralized Tool Grinding

by M. E. Knoll,
Carboloy Co., Inc.

Many plants still are not "sold" on the advantages of centralized grinding of cutting tools. Tools are still being ground by machine-tool operators themselves, with consequent loss of productive time. Improved tool sharpening resulting from centralized grinding will reduce materially shut-downs for tool changes.

Centralized grinding requires less equipment than where it is distributed throughout the plant. In centralized grinding rooms, plants can afford one or two bigger and faster machines for hogging off front and side relief (clearance) of steel shanks, which is particularly important with carbide tools. In centralized work, a single larger and efficient dust collector suffices. A reduced inventory results, as to wheels, templates and tools, and a smaller number of tools is in circulation in the plant.

There are also reductions in supervisory costs, tool spoilage and grinding time. Men who specialize in grinding will attain higher proficiency and take special pride in that work. Among the grinding specialists is more interchange of ideas, short-cuts and improved techniques. The system allows for setting up time limits, or productive periods, between grinds, thus preventing damage from use in a too dull condition.

The biggest gain from centralized grinding is with the much-neglected single point tool.

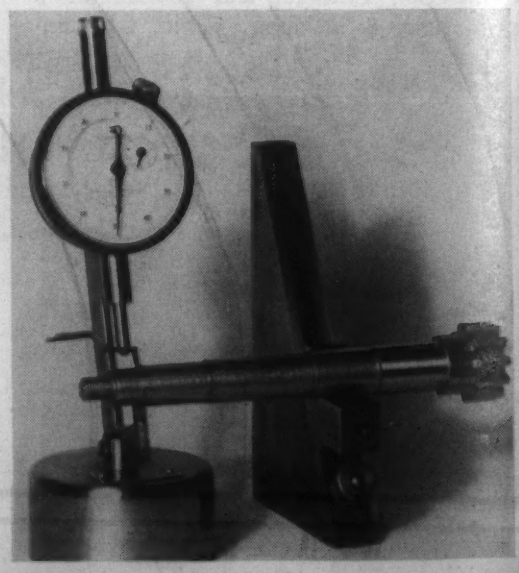
Modified Indicating Gage

by R. E. Hulse,
General Electric Co.

Apparently an inspection method for checking groove diameters close to a shoulder on a shaft has been found that is superior to previous conventional routines, particularly where there is a series of different diameters on the same shaft. Snap gages have their limitations in that the older, fixed type flat gages with Go and No-Go slots become worn and sprung with use and lose their accuracy. Improved adjustable snap-type gages with Go and No-Go slots, while they can be checked with Johannsen blocks and readjusted to compensate for wear, go out of adjustment too frequently.

In the screw machine department of General Electric Co. at Schenectady, we added a slender blade and lifting lever to the plunger of an indicating instrument and a similar slender (1/64 in.) blade projection up from the base holding the gage.

The blades proved so satisfactory that use of such gages was expanded to checking both diameters and out-of-roundness of many types of shafts having a series of different diameters. Had ordinary snap gages been employed, several would have been required for one shaft, and

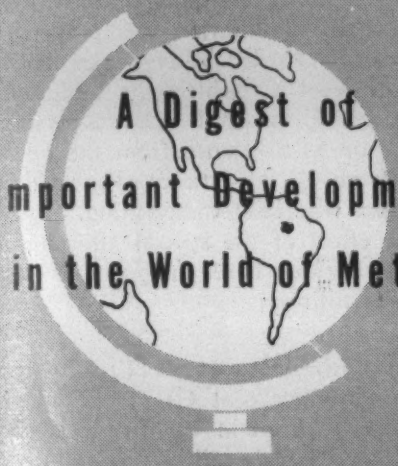


they would not indicate the degree of out-of-roundness.

For inspecting shafts without grooves, we produced a similar attachment for a standard indicating gage, with a slender blade on only the instrument plunger.

The accompanying photograph reveals the dial gage equipped to measure narrow groove diameters.

Metallurgical Engineering Digest



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1 Metal Production

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Boron in Steel

A Composite

One of the permanent metallurgical products of the war is certain to be the regular use of boron-bearing addition agents to produce heat-treated steels of high hardenability and good all-round mechanical properties with relatively low alloy content. Although considerable detailed data on boron-treated steels cannot yet be released, enough information has recently been published [see, for example, the article by Comstock on p. 978 of the May issue of METALS AND ALLOYS] to permit a factual appraisal of their merits.

From a mass of data submitted by manufacturers of alloy addition agents, steel companies and consumers of steel, the American Iron and Steel Institute (*Contributions to the Metallurgy of Steel*, No. 9, Nov. 1942) recently published a report of hardenability and mechanical-property tests on boron-treated steels. The data were determined on production basic open-hearth heats and show the state of this art at that time.

In the opinion of the committee preparing the report, all the special boron-containing addition agents then available are effective in producing the results observed (no report was made on special addition agents containing vanadium).

An increase in hardenability was observed in all of the data and was largely independent of the type of alloy added, provided the correct quantity was used and the method of addition was proper. The increase in hardenability varies with the type of steel to which the addition was made. The Rockwell hardness values of 30, 40 or 50 (distance from the quenched end) were 1½ to 5 times as great depending upon the base composition.

The effect of the special alloy additions on the various base compositions appears to be as follows:

(1) Carburizing steels (up to approx. 0.25 per cent C)
  (a) In plain carbon steels the effect is mild.
  (b) In higher manganese and alloy steels the effect is more pronounced.
(2) Medium carbon steels (approx. 0.30 to 0.60 per cent C)
  (a) In plain carbon steels the effect is marked but varies, depending on manganese content.
  (b) In the higher manganese and alloy steels these addition alloys appear to be most effective.

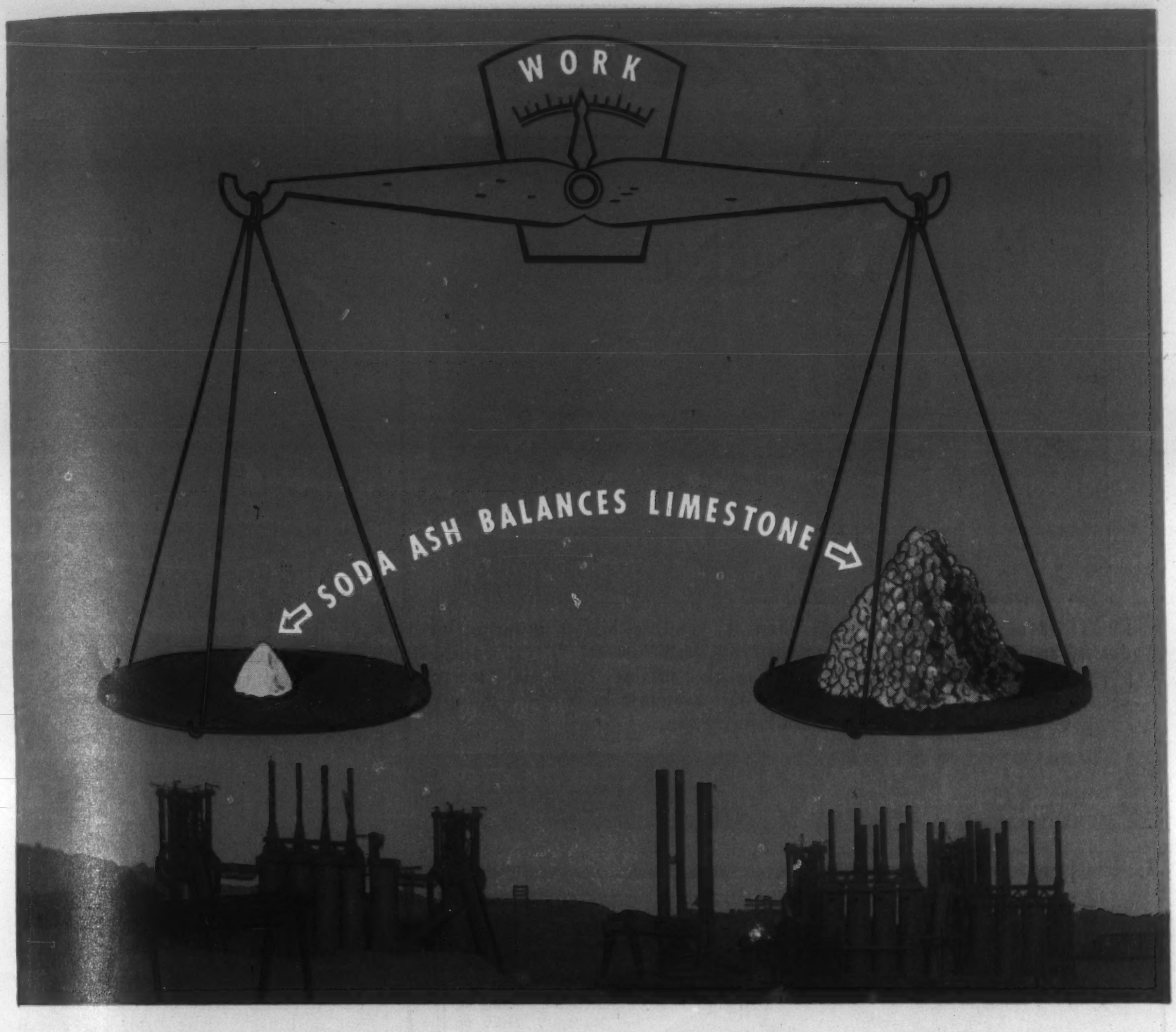
No conclusive data were available on the high hardenability steels because of the limitations of the hardenability test. All the hardenability data were obtained from the standard end-quench hardenability test bar except as otherwise noted.

Mechanical Properties

The proper addition of the special alloys was beneficial, as indicated not only by an increase in hardenability but also a corresponding improvement in tensile properties. This improvement in hardenability was accompanied by an increase in strength in critical sections either with an increase in ductility and toughness, or without normal corresponding loss in ductility and toughness, depending on the magnitude of the strength increase.

The improvement of the ratio of the yield to ultimate strength was greater at higher tempering temperatures. The improvement in ductility was greater when a low tempering temperature was used to produce high hardness values.

Notched-bar sensitivity was improved by the addition of the special alloys to steels which may be used at high hardness values in the as-quenched condition or after low-temperature tempering. The data studied show that the physical properties of steels treated with special alloy addition agents were not materially improved when the



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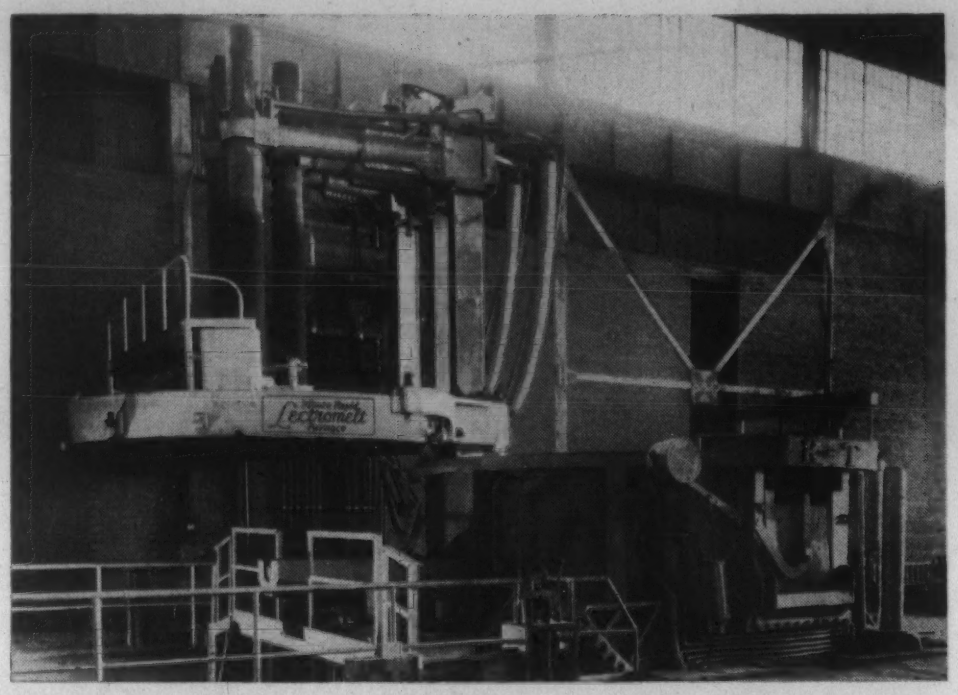

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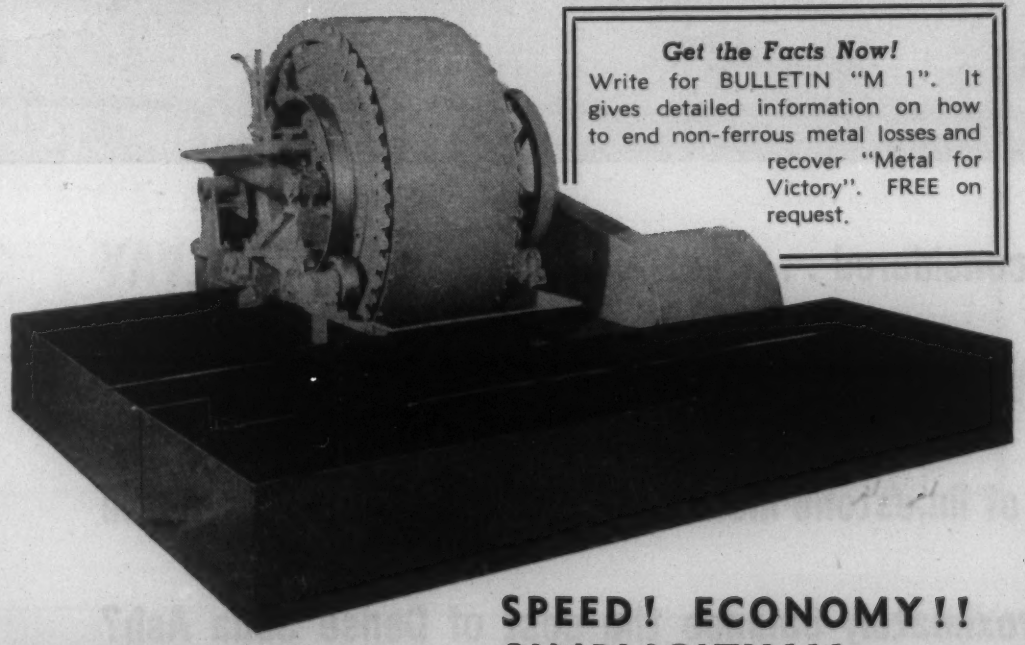

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steel was normalized as a final thermal treatment.

It was indicated clearly that the special alloy addition agents were very effective in enhancing mechanical properties, the degree depending upon the base composition of the steel under study. For example, in steels of low-hardening capacity which will not harden throughout in the sections involved, a substantial increase in tensile strength may be obtained.

For steels of high-hardening capacity the results obtained were not proportionate. The reason is, of course, that steels of high hardenability contain enough alloy to secure the maximum which can be obtained in the section involved. All the mechanical property data presented are for either 1-in. rounds or preliminary machined test specimens, heat treated as shown.

A general summary of the study shows that the use of special alloy addition agents will increase, with varying effect, the hardenability of all grades of steel studied, the degree being dependent on the base composition. The most beneficial effect of the use of these agents on mechanical properties, especially ductility, is in steels heat-treated to high hardness levels. To obtain the maximum results for any property, the steels to which these agents have been added must be quenched and tempered.

Making the Additions

An interesting survey of the available commercial boron alloys and methods of adding them is presented by T. W. Lippert *(Iron Age,* Vol. 150, Nov. 19, 1942, pp. 41-44). Boron, he states, is characterized by a high affinity for oxygen and is, therefore, a superb deoxidizer.

The effect of boron when present in the form in which it can act, presumably in solid solution in steel, is limited by the amount which can be held effectively, and the disastrous effect of excess boron on hot ductility. About 0.002 per cent B seems to be the most effective amount, and more than 0.003 per cent causes trouble in hot working.

Boron should be added to steel in such a way that it is protected from oxidation or other chemical combinations and that it be uniformly distributed throughout the molten metal. Mold additions are impractical, while ladle additions are recommended.

Seven and one-half pounds of one boron-containing alloy per ton is a recommended initial addition, but this may be tapered off in subsequent heats to arrive at the most economical amount. The just-mentioned addition amount is generally sufficient in itself for deoxidation purposes and is equivalent to about 1.1 lb. of aluminum per ton of steel. If the amount of boron alloy is reduced to say, 5 lbs. per ton with satisfactory effects on hardenability, additional aluminum should be added.

The very small amounts of boron that need be added call for a high degree of skill in adding this to molten steel. Since boron readily oxidizes, it must be added only to a completely deoxidized steel bath, or it must be accompanied by enough strong deoxidizers to protect it until it is

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A simple, economical, and highly satisfactory form in which to employ Boron for such use is a special Ferro-Boron developed by the Molybdenum Corporation. Compositions and procedures have been minutely checked and clearly defined.

Literature is available. On any application of Boron, Molybdenum, or Tungsten, correspondence is invited.

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dissolved in the molten steel, otherwise the recovery and the consequent effect will be erratic.

The amount of boron to be added is so small that it could be difficult to obtain good dissemination throughout the steel if it were added in the form of pure boron or very high boron alloy. Therefore, there are ferroboron alloys available for this purpose.

Boron is no cure-all for all of the difficulties encountered. It may exert secondary effects not yet noticed in the tests made, but so far no unfavorable ones have shown up. Boron-bearing steels can be forged, rolled and machined at least as readily as conventional alloy steels of the same carbon content and hardenability.

According to N. F. Tisdale *(Blast Furnace & Steel Plant,* Vol. 31, Jan. 1943, pp. 93-94) a ferroboron alloy has been developed which permits rapid absorption of the boron into the liquid steel and affords high recovery of the boron added. The alloy contains 10-12 per cent B and a maximum of 3 per cent each of carbon and silicon. About ½ lb. will give the recommended amount of boron to be added to the steel.

Some Specific Effects

Addition of 0.007 per cent B to the common varieties of steel makes the material so hot short that it is rolled with difficulty and greater amounts result in broken billets and blooms. Addition of 0.003 per cent gives the maximum results when measured in increased hardenability, elastic limit, and ultimate strength.

The boron may be added to the old S.A.E. specifications, keeping the other alloying elements on the low side, or entirely new steels may be made patterned after a carbon steel with 0.003 per cent B and the required amount of other elements to obtain the physical properties desired. Many cases will require no additional elements.

As an example, a split heat of S.A.E. 1035 steel was made with and without boron. The average results obtained on a 1-in. round quenched in oil from 1500 deg. F. and drawn at 1000 deg. F. were:

	Plain	With boron
Ultimate strength, lbs. per sq. in.	109,000	124,000
Elastic limit, lbs. per sq. in.	85,000	109,000
Elongation, per cent	22	21
Reduction of area, per cent	62	60

Boron-treated steels which are heat treated by liquid quenching and drawing represent the most fertile field. The small amount of boron added will replace 1 per cent Ni, 0.30 Cr, 0.20 Mn, 0.12 V, and 0.10 per cent Mo.

The manufacture of boron-treated steel requires careful attention to details during melting, but subsequent operations are the same as for a regular carbon steel. There seems to be a little in favor of boron steels in regard to chipping costs and machinability.

There is a gradual increase in the physical properties of the steel treated as the amount of boron added increases from 0 to 0.003 per cent. Beyond this amount, the effect decreases until at 0.007 per cent the effect is harmful.

Boron is more responsive to steels containing 0.20 to 0.60 per cent C. Above 0.60 per cent C, the steel has sufficient hardenability in small sections without boron. In the higher carbon range, boron is used in the larger sections, such as large forging billets. In the low carbon steels, boron exerts some benefit in such steels as are heat treated.

A very good review of the above points, with many additional details, will be found in a group of short papers presented at a recent A.S.M. symposium *(Metal Progress,* Vol. 42, Dec. 1942, pp. 1061-1069).

Steel Plant Refractories

Condensed from
"Iron and Steel Engineer"

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production. Silica brick of greatly improved properties are now available. Since the furnace temperature is limited by the point at which the roof brick begin to melt or drip, super-duty silica brick of appreciably higher refractoriness are very promising.

It is difficult to measure refractoriness with the Pyrometric Cone Equivalent method, but the standard load test, with bricks set on end and a load of 25 lbs. per sq. in. applied during heating, show that high quality silica bricks will withstand a temperature of about 3000 deg. F., while super-duty brick withstand about 3085 deg. F. Some operators have secured as much as 25 per cent increase in number of heats with super-duty brick in open-hearth roofs.

Super-duty fireclay brick, developed within relatively recent years, are admirably suited for such applications as soaking pit covers. They possess higher refractoriness, lower porosity, greater volume stability and greater strength under load than high heat duty fireclay brick.

High-alumina brick are available in the 50, 60, 70, 80, and 90 per cent alumina classes, with refractoriness increasing approximately in proportion to alumina content. Bricks made from kyanite and sillimanite are included with this class. High-alumina brick containing substantial percentages of corundum are of importance. One such brick in the 60 per cent alumina class shows exceptionally high strength under load and volume stability at high temperatures, and outstanding resistance to thermal shock. A 90 per cent alumina brick containing corundum finds application in piers, supporting arches and other constructions where loads must be carried at high temperatures.

Variables in furnace operation greatly affect the life of refractories. Heavy residual fuel oils may introduce sufficient high alkali ash to cause severe chemical corrosion. Increase of furnace gas pressure increases spalling losses.

Care in the manufacture of refractory brick, such as attention to careful sizing and high pressure forming, are also important. The use of standard size brick, which would be made in power presses, is therefore not only desirable from a cost standpoint, but is good practice from a service standpoint.

High temperature bonding mortars of many kinds are now available, air-set or heat-set, dry or plastic, having various bases.

For electric steel furnace refractories, silica brick are most generally used for larger roofs, while for smaller roofs super-duty fireclay brick or high-alumina brick may be used. Silica brick retain high strength at high temperatures, even in the presence of lime and iron oxides, while fireclay brick have much less resistance to such influences. Basic brick have been used in an experimental way for furnace roofs, and show promise. Hard burned magnesite and metal encased magnesite for side walls will undoubtedly show increasing use in severe conditions.

—C. A. Brashares, *Iron & Steel Engr.*, Vol. 20, Feb., 1943, pp. 48-52.

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Blast Furnace Metallurgy

Condensed from "Steel"

Studies and observations were made on various blast furnaces at the Pittsburgh Works of the Jones & Laughlin Steel Corp. All furnaces were producing Bessemer iron.

Excluding those casts on which the wind blown was under 52,000 cu. ft. per min., the highest rate of production was obtained with an iron temperature of 2690 to 2750 deg. F. Within the temperature range observed, production was about 17.1 per cent less at temperatures lower than 2660 deg. F., and 10.7 per cent at temperatures higher than 2810 deg. F. Only about 35 per cent of the casts observed were within the temperature range for optimum production.

At the temperature at which optimum production is obtained, average silicon range was 1.15 to 1.40 per cent and average sulphur range, 0.035 to 0.055 per cent. While the sulphur is rather high, the cost of reconditioning Bessemer screw steel would not be increased. Bessemer steel for the strip mill must contain less than 0.030 per cent S, so the furnaces are burdened to give this limit.

Production increased directly with the wind blown. When blast volume was increased from 45,000 cu. ft. per min. to 56,000 cu. ft. per min. production was increased 21 per cent. To obtain maximum production it is necessary to maintain the optimum blast volume that the furnace will take.

Comparison of the effects of iron and slag temperatures on the silicon and sulphur contents of the iron indicates that there is a close relationship between iron and slag temperatures.

Iron production reached an optimum when 60 to 80 tons of scrap were charged per day. Although the production was somewhat lower with scrap additions greater than 80 tons, it remained above the average rate of those days with less than 60 tons of scrap.

The furnaces operate with a slag of approximately 10 MgO and 8 to 9 per cent Al_2O_3, varying less than 1 per cent from day to day. Within these limits it is thought that a direct relationship exists between basicity and desulphurization.

A study of the effect of the basicity on production and sulphur in the iron, using molar basicity to represent the chemical composition of the slag, indicated an increase in production of about 7 per cent when operating with a lean slag. The equation used to determine molar basicity was

$$\frac{[\%\ CaO - (1.75 \times \%\ S \text{ in slag})] \div 56 + (\%\ MgO \div 40)}{(\%\ SiO_2 \div 60) + (\%\ Al_2O_3 \div 102)}$$

The slag basicity on which the furnace can operate is determined to a great extent by the sulphur and silicon contents of the raw materials being charged. The installation of a new coal washer has reduced the amount and variation in content of ash and sulphur in the coke, resulting in a leaner slag. Many other advantages have resulted from the use of 100 per cent washed coal for coke.

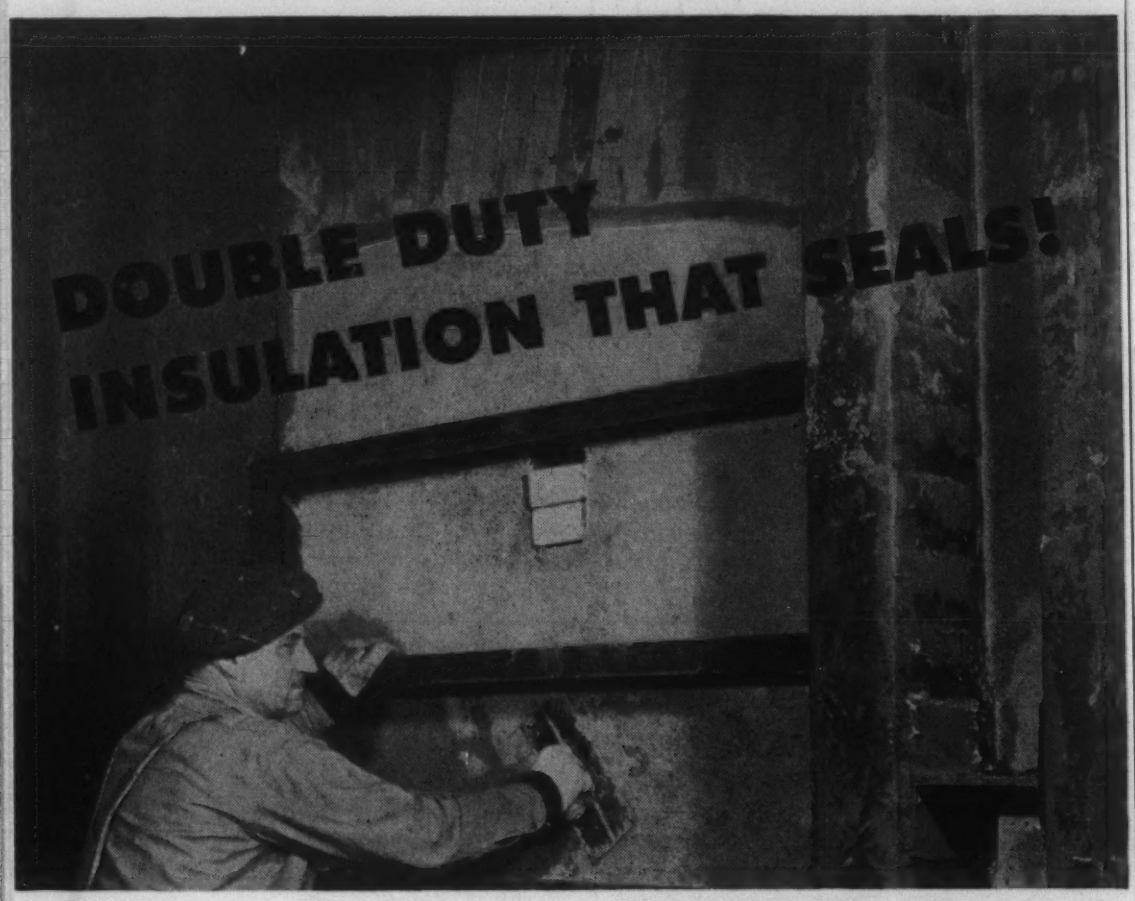
Using ore preparation methods, screening, and washing, iron in the iron ore concentrate was increased 2 to 3 per cent and the size of the ore was larger and more uniform. Test runs charging 100 per cent concentrates indicated an increase in production rate of 60 to 80 tons per day and a decrease in coke consumption of about 100 lbs. per ton of iron.

A test run using 31 per cent New York magnetic [sic] sinter, containing 65.2 Fe and 3.6 per cent SiO_2, showed an increased production of about 100 tons per day and reduced coke consumption of almost 2000 [sic] lbs. per ton of iron. These examples show the importance of using the best possible raw materials available.

Study of slag fluidity showed that the basicity and temperature of the slag increased and sulphur in the iron decreased with increase in fluidity.

It is important to maintain the furnace in balanced equilibrium. Any undue fluctuation in one of the factors is sufficient to influence and upset the others because of their close relationships.

—C. D. Smith, *Steel*, Vol. 112, Mar. 29, 1943, pages 86-88, 91-92.



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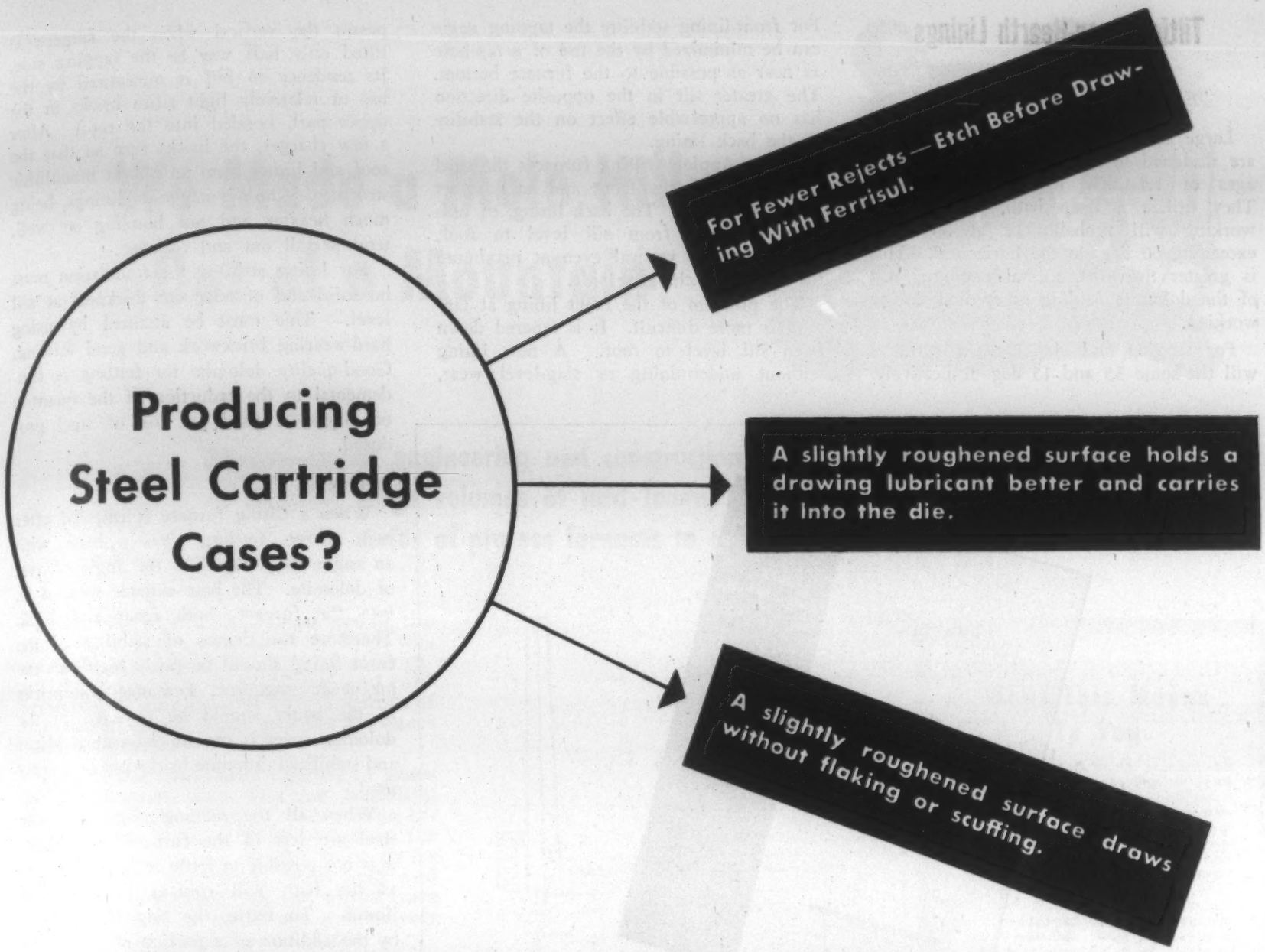


EXPERIENCE of several producers of steel cartridge cases who are etching with Ferrisul before drawing is proving those two facts. Further, their experience is showing that partial removal of surface metal and carrying the lubricant into the die acts to prolong die life and reduce drawing resistance.

Ferrisul (anhydrous ferric sulfate) is a mild acid oxidizing agent which has long been successfully used to etch steel preparatory to such operations as tinning and hot dip galvanizing. Its action on steel is easily controlled, yet extremely rapid — as high as thirty times that of sulfuric acid. As a result, it produces a sharp, fine-grained, uniform etch.

Because Ferrisul's action results from an ionic charge rather than from hydrogen formation, there is no danger of acid fumes or hydrogen embrittlement. A dry granular powder, it is easy to store and handle.

For full details and experienced technical assistance, inquire: MONSANTO CHEMICAL COMPANY, Merrimac Division, Everett Station, Boston, Massachusetts.

P. S. Ferrisul acts as a passivating agent on 18-8 and similar alloys. If you are pickling steel cases with sulfuric acid and your 18-8 equipment is being attacked, Ferrisul in the sulfuric bath will protect your equipment.

MONSANTO CHEMICALS
SERVING INDUSTRY...WHICH SERVES MANKIND

FERRISUL for metal pickling...etching

Tilting Open-Hearth Linings

Condensed from
"Blast Furnace and Steel Plant"

Large basic open-hearth tilting furnaces are designed to work with large percentages of relatively impure molten iron. They utilize a deep bath, which when working will probably be at an angle exceeding 60 deg. to the horizontal. This is greater than the normal angle of rest of the dolomite fettling as applied during working.

For tapping and slagging the furnaces will tilt some 35 and 15 deg. respectively. For front-lining stability the tapping angle can be minimized by the use of a tap-hole as near as possible to the furnace bottom. The greater tilt in the opposite direction has no appreciable effect on the stability of the back lining.

In the Appleby tilting furnaces the steel casing of both the front and back is set at about 80 deg. The back lining, of uniform thickness from sill level to roof, just passes the vertical even at maximum tilting to the charging side.

The problem of the front lining at tapping is more difficult. It is tapered down from sill level to roof. A new lining without undermining or slag-level wear, passes the vertical when the furnace is tilted only half way to the tapping side. Its tendency to fall is minimized by the use of relatively light silica bricks in the upper part, bonded into the roof. After a few charges, the bricks fuse so that the roof and lining form an almost monolithic structure. Chrome-magnesite linings, being much heavier and not bonding so well, tend to fall out and collapse.

For lining stability the foundation must be solid and of adequate thickness at sill level. This must be attained by using hard-wearing brickwork and good fettling. Good-quality dolomite for fettling is fundamental to the reduction of the quantity of magnesite used per ton of steel produced.

Fettling

When a tilting furnace is emptied after each charge, fettling gives a bank with an angle about equal to the angle of rest of dolomite. The base extends some 4 ft. into the furnace, both front and back. Therefore the degree of stability of the front lining should be fairly high and the magnesite usage low. Few magnesite bricks in the banks should be required as the dolomite cover is very thick in most places and stabilized dolomite bricks can be largely used.

When all the refining slag and some steel are left in the furnace at tapping, it is not possible to fettle from the bottom, as the bath will contain 12-20 in. of liquid. To fettle, the slag is thickened by the addition of a portion of the charge and the dolomite rests on the almost solid slag. Fettling is applied only round about the normal slag line where most of the cutting takes place.

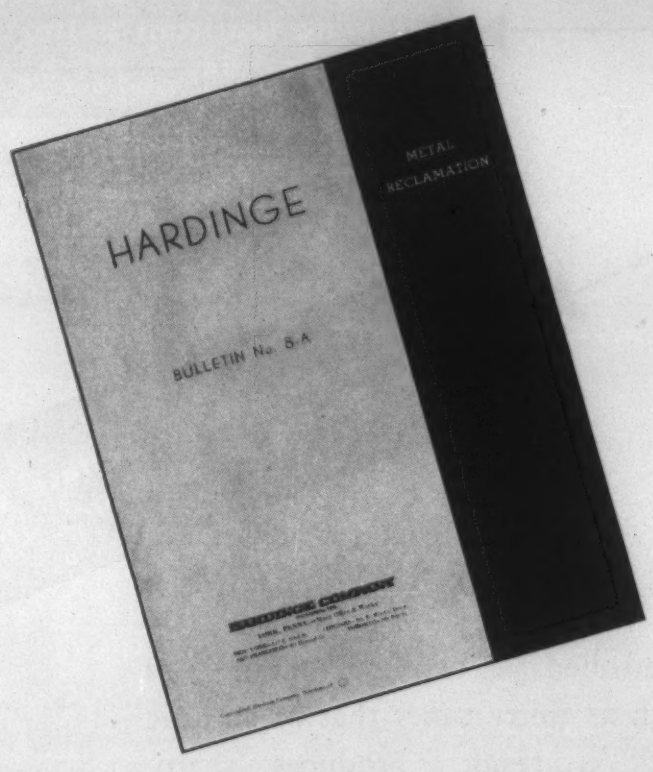
This method gives greater output, but greater attack of the magnesite brickwork is liable to take place, reducing the stability of the upper lining. If the bricks are not highly resistant, the lining is undermined deeply and the cavity cannot be filled tightly with dolomite. The only satisfactory way to fill deep undercutting is by using a wet chrome-magnesite paste.

Types of Bricks

Experiments have shown that: (a) Magnesite and chrome-magnesite bricks are not of the same high quality as formerly; (b) chrome-magnesite bricks are probably still superior to magnesite for linings above the slag line; (c) stabilized dolomite bricks can be used in part in the lower portions of the hearth to replace magnesite, but they must be kept covered with fettling; (d) magnesite bricks are still the only satisfactory bricks for use about the slag line.

For patching linings a paste containing 40 per cent of the magnesite, instead of the 70 per cent formerly used, gives reasonable satisfaction except for slag-line patching. It is hoped in the near future to perfect a stabilized dolomite cement with which to repair front linings in place of chrome-magnesite.

—A. Jackson, *Blast Furnace and Steel Plant*, Vol. 31, Mar. 1943, pp. 316-319.



NEW BULLETIN

on

Recovery of ferrous and non ferrous alloys from Foundry Waste. Also Aluminum, Magnesium and Zinc from Dross and Skimmings.

Includes Flow Sheets of wet and dry Systems with complete description of processed, also capacity and specification tables.

Write for Bulletin No. 8-A

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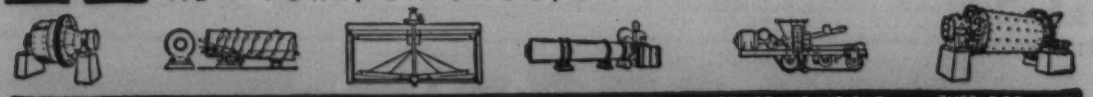


We Made a Mole Hill Out of a Mountain

Bigelow-Liptak engineering and construction methods solved the problem of directing large volumes of acid-laden, low temperature gases from a series of process furnaces to an exhaust chimney.

THE PROBLEM that faced one of the country's largest copper smelters was a tough one. A satisfactory and economical means had to be developed and constructed for carrying off large volumes of acid-laden gases from process furnaces to a chimney.

Due to the enormous volume of gases being released, any flue for handling them would necessarily involve large exposed areas. Such a flue, necessary for directing the gases, would have to be designed for maximum wind load and made weather proof. Also it would have to be air-tight to maintain a relatively high draft or negative pressure.

In order to sustain a temperature high enough at the base of the stack to create the necessary draft, a method for assuring a reasonably low conduction heat loss for the entire flue had to be worked out.

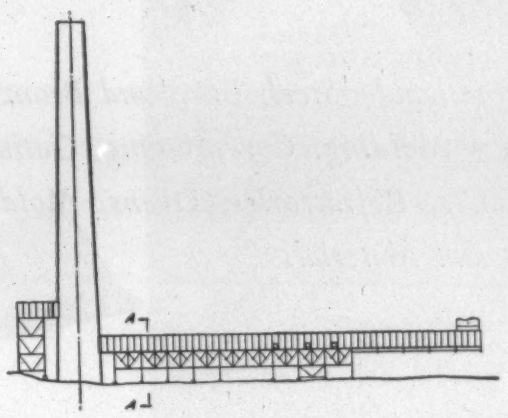
Another factor added to the problem. Adequate provisions had to be made for taking care of the great amount of thermal expansion that would naturally occur in a flue of this length. In designing the flue, means of compensating for this expansion would have to be incorporated in the design.

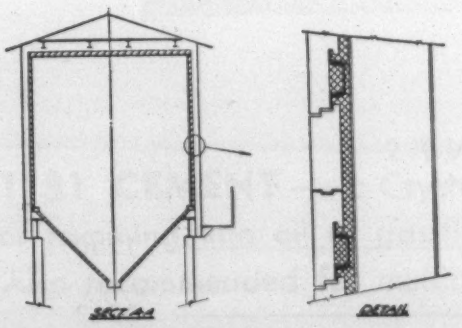
As should be the case, costs had to be an important consideration. Any passage devised would have definite price limitations and the design had to be economical.

The Solution

Bigelow-Liptak engineers visited the job. A complete survey of the problem and all its factors was made and studied. Preliminary drawings for the general design of a flue were made right at the job site. Later, back in the general office complete and detailed drawings were developed and studied by the Bigelow-Liptak engineering staff. A thorough analysis was made of the thermo-dynamics, the mechanics of materials and the ceramics.

As a result of this careful analysis and study, a thoroughly satisfactory and economical means was worked out for directing the acid-laden gases from the furnaces to an exhaust chimney. Recommendations were prepared and cross section drawings of the entire flue — as shown — were submitted.





Unit-Suspended side walls and arches were used for the 350 feet long flue areas. Special acid-resisting refractories were selected. Because of experience, Bigelow-Liptak knew that this type of acid-resisting tile should be manufactured on extrusion machines. This was important in designing the tile, as all special shapes would have to be designed to conform to this process without sacrificing any of the advantages of Unit-Suspended construction. Air tightness and low heat conduction losses, being a natural feature of Bigelow-Liptak Unit-Suspended construction, were easily incorporated into the design, once the major problem had been solved.

Bigelow-Liptak's exclusive designs made possible an uninterrupted weather proof insulation shield or encasement —thereby eliminating the need of critical steel plate—a factor of considerable importance today.

Because of the acid in the gases, ordinary expansion joints could not be used to provide for the expansion and contraction. A special fibre glass had to be employed.

By applying Bigelow-Liptak engineering skill and principles, the problem of finding a satisfactory means of transferring acid-laden gases to an exhaust chimney, was solved.

What This Means To You

The significance of this problem and its complete solution by Bigelow-Liptak is much greater than any resemblance it may have to any of your problems. It serves to demonstrate the value you may receive by taking your problems to Bigelow-Liptak regardless of their type or size. Bigelow-Liptak's wide experience in designing enclosures includes every type of problem having to do with thermo-dynamics, ceramics and mechanics of materials. With Bigelow-Liptak there is no standard or set solution for every case. Individualized engineering, based on years of experience and sound engineering principles, is applied towards giving the customer the best and most economical solution to his particular needs. Our policy is to give first and foremost consideration to the needs of the user.

Engineering Information
No Obligation

Our engineering staff will be glad to send you interesting catalogs or tell you how you could secure increased service and economy by the use of Bigelow-Liptak Unit-Suspended walls and arches in your plant. Write today.
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327 Curtis Building
Detroit

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Unit-Suspended Walls + Arches

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DETROIT

2 Foundry Practice

Melting and Pouring of Gray Iron, Malleable, Steel, Brass and Bronze, Aluminum and Magnesium Castings • Molding, Core-Making, Gating and Risering, etc. • Foundry Furnaces, Refractories, Ovens, Molds, Sands, Binders, Auxiliary Equipment and Materials

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The Rocking Electric Furnace

Condensed from an Electrochemical Society Paper

This is a history of the development of the rocking electric furnace. Dr. C. L. Parsons, then chief mineral technologist of the U. S. Bureau of Mines, published a bulletin in 1911 in which he reasoned that much zinc was volatilized and lost from the fuel-fired furnaces then standard in the brass industry. He hired H. W. Gillett and J. M. Lohr for experimental work on the problem. Mr. Lohr later went into industry and was replaced by E. L. Mack. An extensive survey of commercial practice verified Dr. Parsons' appraisal that metal losses were large.

Early Development

In the course of the experimental work directed toward improvement of brass-melting practice, many types of furnace were tried. It became evident to the investigators that heating by radiation, through a crucible wall or from a resistor radiating to the roof and thence down to the bath, or even from a carbon-plate or a Thompson-Fitzgerald zigzag resistor over the bath, was hopelessly inefficient compared to generating the heat inside the metal, as in the Ajax-Wyatt or Ajax-Northrup types.

Direct arc heating was unsatisfactory because of the local overheating of the surface of the melt. The Ajax-Wyatt and Ajax-Northrup types of furnace were in an early stage of development and were decidedly expensive.

To accomplish, in effect, internal heating of the charge, the scheme was evolved of rocking back and forth a drum-like, horizontal cylinder indirect arc furnace, so that as soon as the metal was molten, what had previously been the roof of the furnace was washed by the metal and much of its stored heat given back to the metal. At the same time the local overheating of the surface in a stationary-arc furnace was avoided by the accompanying agitation. The first furnace of this type was made in 1915 at Cornell University, Ithaca, N. Y., from an old ether drum.

As a result of the potentialities shown in the experimental work, E. L. Crosby and Alex Dow of the Detroit Edison Co. had the first commercial rocking furnace built in their shops. It had a capacity of 1300 to 1950 lbs. It was installed and tested in 1917 in the plant of the Michigan Smelting & Refining Co., Detroit. As a result of the success of this first commercial unit, four others were soon built and operated at the Detroit plant.

In 1918 E. L. Crosby left the Detroit Edison Co. to form the Detroit Electric Furnace Co. for the further development and marketing of the rocking furnace. The patents had been assigned to the Secretary of the Interior as trustee, and a free, non-exclusive license was granted to the Detroit Electric Furnace Co. The patentees have had no financial interest in the Detroit Electric Furnace Co. and all subsequent developments have been made by the latter company.

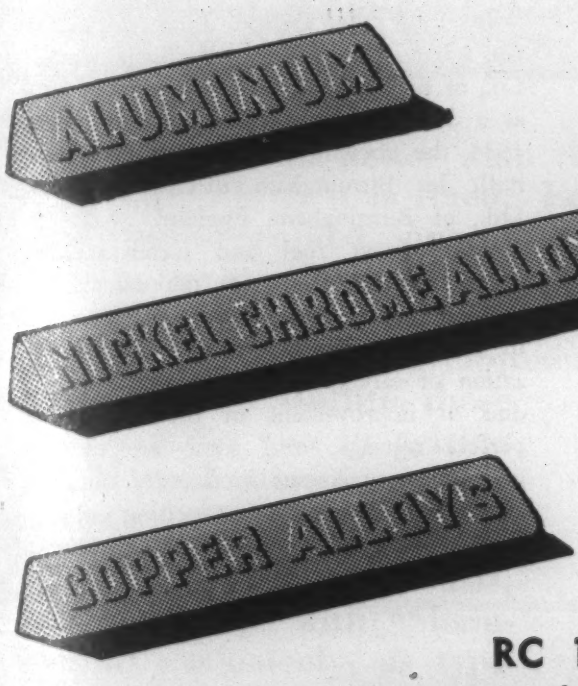
Commercial Growth

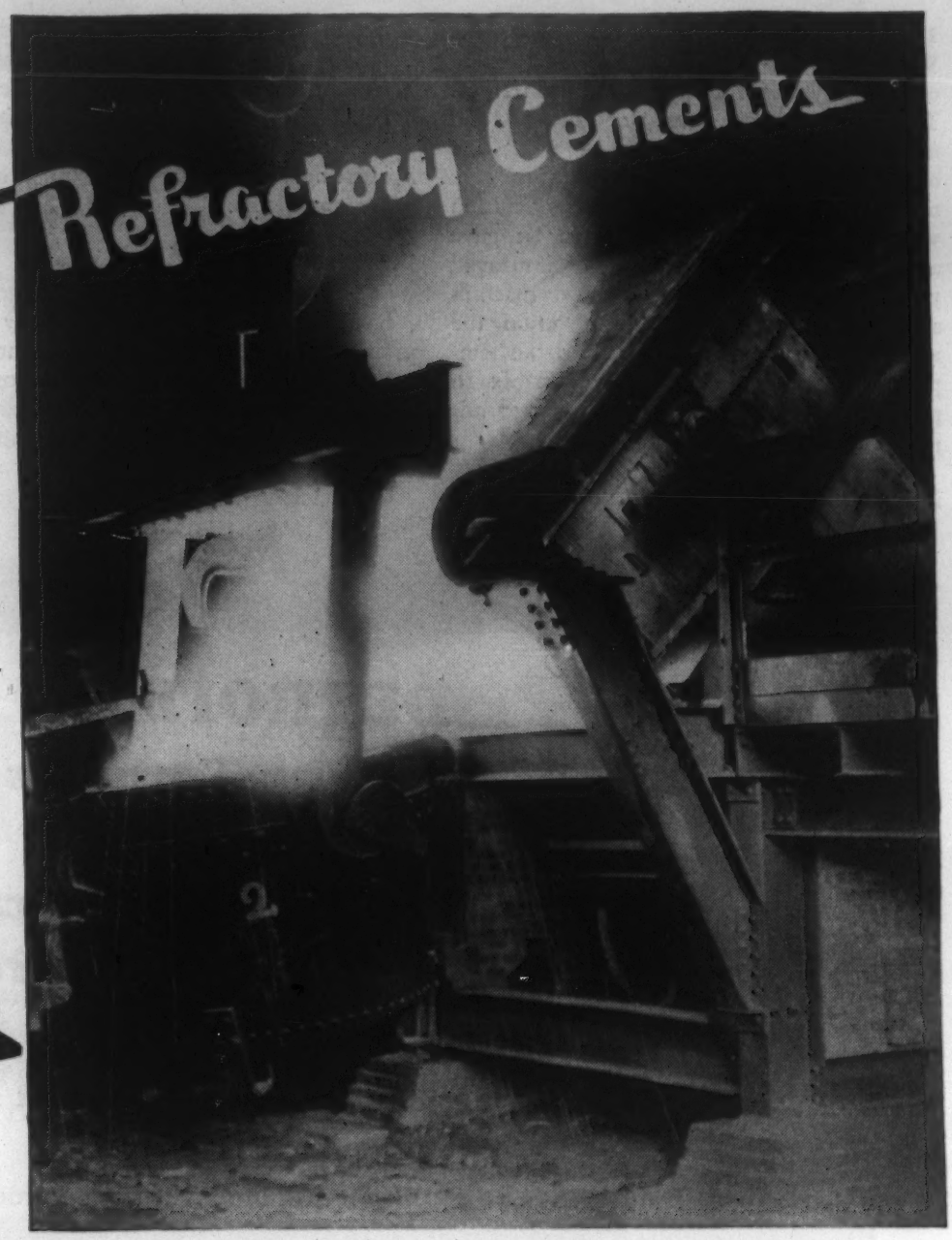
There are today 765 rocking furnace installations throughout the world. Most of these range in size from 250 to 4000 lbs. cold scrap charging capacity (350 to 8000 lbs. molten metal) per heat. They are now melting virtually all types of commercial alloys, ferrous and non-ferrous. The most popular furnace has been the Type LFA, 350-lb. unit. Approximately 50 per cent of all furnaces sold since 1924 are of this rating. A typical days' log from one plant using this furnace shows a 400 lb. heat of bronze every 35 min. Refractory costs are low. One operator's refractory costs are less than 30 cents per ton of melt. Most operators average about 3000 heats per lining on brass and bronze. Metal losses are very low.

The first successful rocking furnace installation on ferrous work was made in

NORTON

FOR MELTING





RC 1131 CEMENT — a Crystolon (silicon carbide) cement of very high refractoriness for ramming into oil or gas fired reverberatory and pit furnaces melting aluminum. Also recommended for melting copper and zinc.

RM 1169 CEMENT — a fused magnesia cement, ideal for lining Ajax-Northrup high frequency furnaces melting nickel-chromium alloys. Linings of this cement have given up to 400 heats in 600 to 1000 pound furnaces.

RM 1140 CEMENT — a fused magnesia cement for rammed linings in Ajax-Wyatt low frequency vertical ring induction furnaces melting high copper alloys (more than 85% copper), copper-nickel alloys, nickel silver, and cadmium bronzes. Successfully used by America's largest copper and brass melters.

NORTON COMPANY, Worcester, Mass.

NORTON ELECTRIC FURNACE FUSED REFRACTORIES

1927. It was a 250-lb. furnace at the Westinghouse Air Brake plant, duplexing cupola gray iron for air brake piston rings. The molten iron was superheated and mixed in the rocking furnace with the necessary additions of ferrosilicon to give the required chill depth. The operation was successful from the start for it gave a product of great uniformity, of improved physical properties, and better machinability. In this type of application the ability to control the analysis and the temperature is important. It is possible to pour a test piece for examination and adjustment before tapping the heat.

Other installations, for melting gray iron borings, for making "quick anneal malleable," and for melting steel are described. In the case of alloy steels, the rocking furnace has proved quite successful. For carbon steels, except in 500-lb. sizes or smaller, their use has, so far, been questionable, principally because of refractory problems.

The Furnace Today

Several improvements in furnace design have been made recently. Probably no other single factor is of such importance in the operation of the rocking furnace as the proper observance of the rocking cycle. Failure to rock adequately and increase the angle of rock regularly results in higher metal losses, higher consumption of power and electrodes, and more severe refractory wear. An automatic rocking controller is now standard on all furnaces of 200-lb. capacity and over, thus eliminating the human element in rocking control and increasing furnace efficiency.

Since 1937 a conical shell design has been introduced on some sizes. This eliminates the tendency toward "cold end zones" present in the cylindrical shells.

Electrodes are non-rotating and are not attached directly to the shell. This permits rapid replacement or interchange of shell assemblies, either to install a new lining without a furnace shut-down, or to change to a different type of melt. Electrodes are now hydraulically operated for smoother operation.

External tap changers have been added to the transformers so that the reactance and voltage can be changed depending on local conditions and operating requirements. On earlier installations it was necessary to open the transformers to make these adjustments.

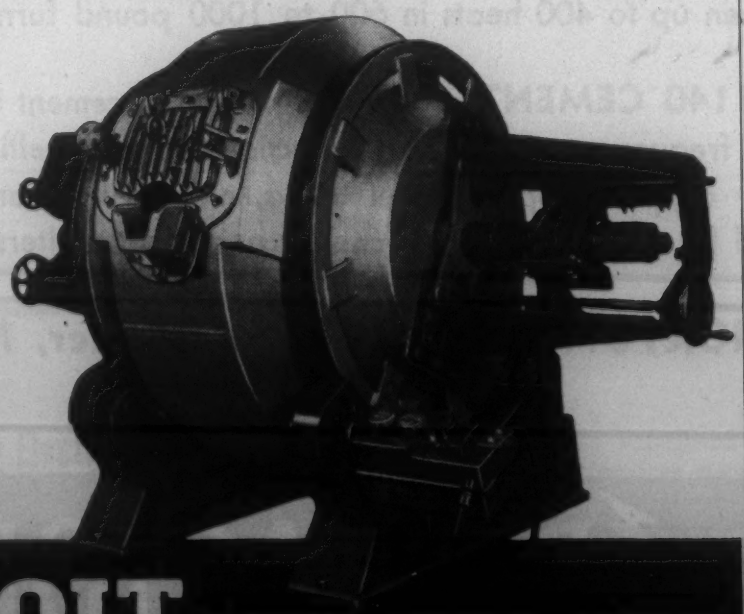
In 1938 the Detroit Electric Furnace Co. was purchased by the Kuhlman Electric Co., of Bay City, Mich. It is now operated as a division of the latter company. Since 1934 the rocking furnace has also been built by Birmingham Electric Furnaces, Ltd., of Birmingham, England.

Aside from fuel and metal savings, economies resulting from the use of the rocking furnace have been many. Some of these savings are due to the direct utilization of salvage raw materials, some are due to improvement in the "yield" of perfect castings, and some are due to general improvements in foundry efficiency as a result of using a fast-melting unit.

—H. W. Gillett and A. E. Rhoads, *Trans. Electrochem. Soc.*, Preprint 83-3, Apr. 1943, 24 pp.

DETROIT
Melting Furnaces for Precise Metallurgical Control

For close chemical and metallurgical control of any desired ferrous or non-ferrous alloys, the Detroit Rocking Electric Furnace with its exclusive, automatic stirring action under non-oxidizing conditions simply cannot be beaten. You can run a different mixture on each subsequent heat or the same alloy all day long with remarkable uniformity. Write today for complete facts about this fast melting, efficient, labor saving, money making foundry tool.



DETROIT ELECTRIC FURNACE DIVISION
KUHLMAN ELECTRIC COMPANY • BAY CITY MICHIGAN

Reclaiming Porous Castings

Condensed from "Foundry Trade Journal"

For overcoming porosity in metal castings, sealing solutions Bakelite V. 1845 and No. 2106 can be used. The former is a clean solution of a special resin, and is used in cases of fine porosity, whereas the latter is a solution containing a finely divided mineral filler and is employed when the porosity is of a grosser nature. These solutions may be used for both ferrous and non-ferrous metals, and factory trials have demonstrated conclusively that the results produced are highly satisfactory.

Two Main Methods

There are two main methods, one for small castings, by which the sealing solution is forced into the casting by external pressure, and the other, for large hollow castings, by which the solution inside the casting is subjected to pressure, thereby forcing the solution through the walls from the interior.

The small castings can be treated by the vacuum-pressure process, in which the castings are placed in a strong container from which the air can be evacuated. When

REFRACTORY PRODUCTS OF EXTRA LONG LIFE . . . .

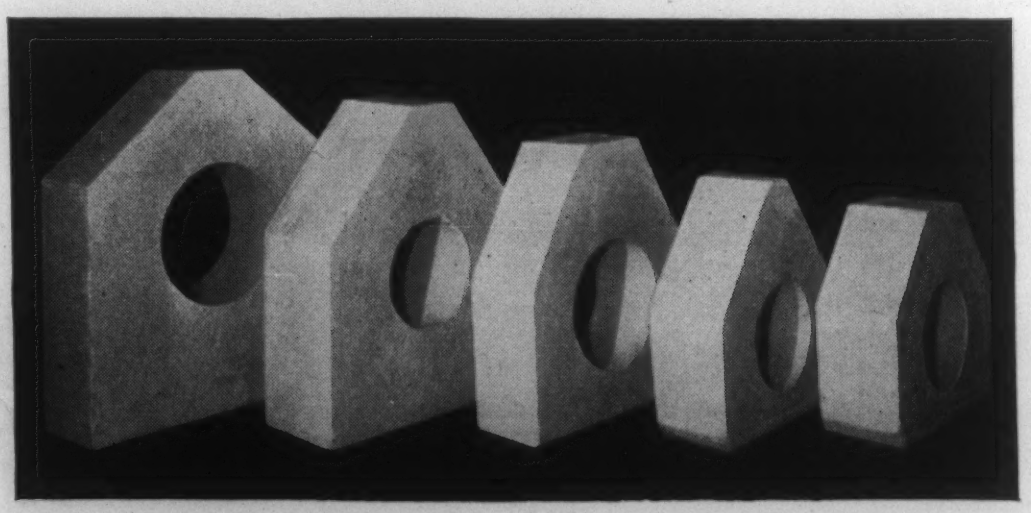
A FURNACE is no better than the refractory with which it is lined. Economical and uninterrupted operation depends largely upon the quality of the refractory used. Because "Shamva" Mullite super-refractories embody the MAXIMUM development of the unique qualities of Mullite, these refractories assist you in getting MAXIMUM production from your furnaces.

Purely on a performance basis, users decide to line with "Shamva" Mullite exclusively, as typified by the following comment:

> "We have used numerous refractory linings in our Ajax Wyatt melting furnaces and have found that 'Shamva' Mullite gives us very satisfactory results both in fast melting and long life. We are, therefore, using it exclusively for the melting of cartridge brass strips."

Don't gamble with refractories which cost many times their quoted price because of frequent shut-downs for repairs. The hidden cost of this type of material is extremely serious when production is so urgently needed.

Let "Shamva" Mullite assure you the extra long refractory life which it is bringing to so many furnace users on linings, pot rests, covers, burner blocks, muffles, heating element forms, electric furnace roofs, spouts, nozzles, strainers, ports, etc.



Preformed blocks for Ajax-Wyatt furnace. The largest of these blocks is 37" high and weighs 648 lbs.

TRADE MARK

"Shamva" Mullite

SUPER-REFRACTORIES

Distinctive Features of "SHAMVA" MULLITE:

- High softening and fusing point: fuses at 3335° F.
- Minimum expansion and contraction
- Low heat conductivity.
- Resistance to spalling.
- Ample load bearing capacity.
- Chemical neutrality.
- Resistance to slag and abrasion.

THE MULLITE REFRACTORIES CO., SHELTON, CONN.

Pioneers in Mullite Super-refractories

Manufacturers of "Shamva" Mullite Bricks, Special Shapes and Cements for all purposes for Ferrous and Non-Ferrous Melting and Heat-Treating. Special shapes of endless variety including all types of burner blocks, linings, arches, roofs, etc. Cements in types to suit every demand for power ramming, hand ramming, air setting, dry patch, wet patch, mortar, etc.

a suitable vacuum has been attained, the sealing solution is allowed to run in from the storage vessel until the castings are covered, after which pressure is exerted for a convenient time. The solution is thus squeezed into the casting, filling the pores. After removal from the vacuum-pressure chamber, the castings are submitted to a baking operation.

In the case of larger hollow castings, an example may be taken of one having several outlets. All but one of these outlets are closed, the open one being used for filling the casting with the sealing solution and as an opening through which pressure may be exerted. The casting may be either in trimmed or untrimmed condition.

When the hollow casting is filled with the sealing solution, air pressure is applied at the open end, so that the solution is forced from the interior into the pores of the metal. Any available pressure from 50 up to 250 lbs. per sq. in. may be used. If any porosity exists, the solution is forced through so that sweating occurs on the outside surface of the casting, although in the case of gross defects the solution emerges as a spray.

While it is probable that a casting showing such leaks would be returned to the foundry, it may be stated that even severe porosity can be cured by two impregnations of the solution No. 2106, followed by intermediate stoving. By this impregnation process, which is carried out at normal atmospheric temperatures, some of the sealing solution remains within the walls of the casting; the next step is to "fix" it therein.

The solution consists chiefly of a Bakelite synthetic resin, which, by the application of heat, is converted from a soluble and fusible substance into a solid which is no longer soluble or fusible, and which is highly resistant to nearly all forms of attack. This transformation is known as polymerization and Bakelite in this cured condition has no known solvent.

The first stage of the baking process removes the solvent, and further heating leaves the pores of the casting filled with a chemically inert solid which cannot be removed by any pressures applicable to the casting in service or on test. Polymerization procedure was discussed by the author.

—W. Bowman, *Foundry Trade J.*, Vol. 69, Feb. 18, 1943, pp. 135-138.

Official OWI Photo

The Crucible Furnace...

MOST CAPABLE NONFERROUS MELTING UNIT

Capable of rapidly producing clean metal with minimum skill or training of attendants.

Capable of melting a variety of alloys by simply changing the metal charged.

Capable of using oil, gas, or solid fuel.

Capable of expansion of plant to fit closely actual output required.

Operating Note: The tilting type furnace as illustrated requires a vessel for carrying but eliminates the tongs necessary for pulling pots as in the stationary furnaces. For best results use a standard crucible of the desired size for carrying.

For further information write a crucible furnace manufacturer or to the address below.

Illustration shows a tilting type crucible furnace, 450 lb. aluminum alloy capacity with a No. 70 standard melting crucible for carrying. (see "operating note" at left below) The photo by Palmer is supplied by OWI.

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90 WEST STREET, NEW YORK, N. Y.

Tin-Free Gear Bronze

Condensed from "Foundry Trade Journal"

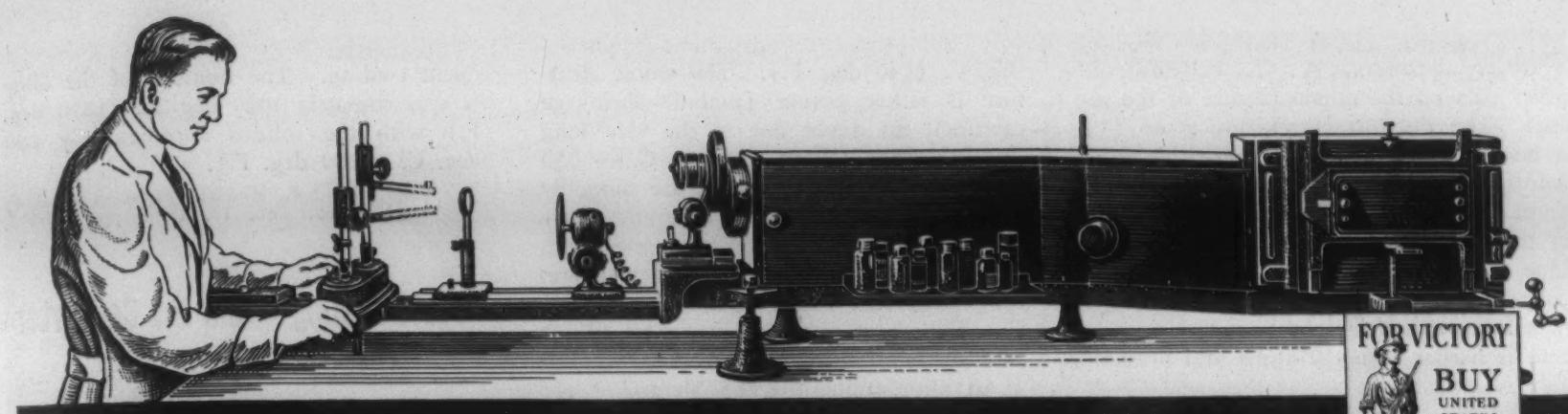
This article describes a research conducted by the Phosphor Bronze Co. on the foundry technique and characteristics of a copper-antimony-nickel alloy, developed by the Hamilton Gear & Machine Co. of Toronto [*see Metals and Alloys*, Vol. 17, Jan. 1943, p. 126.]

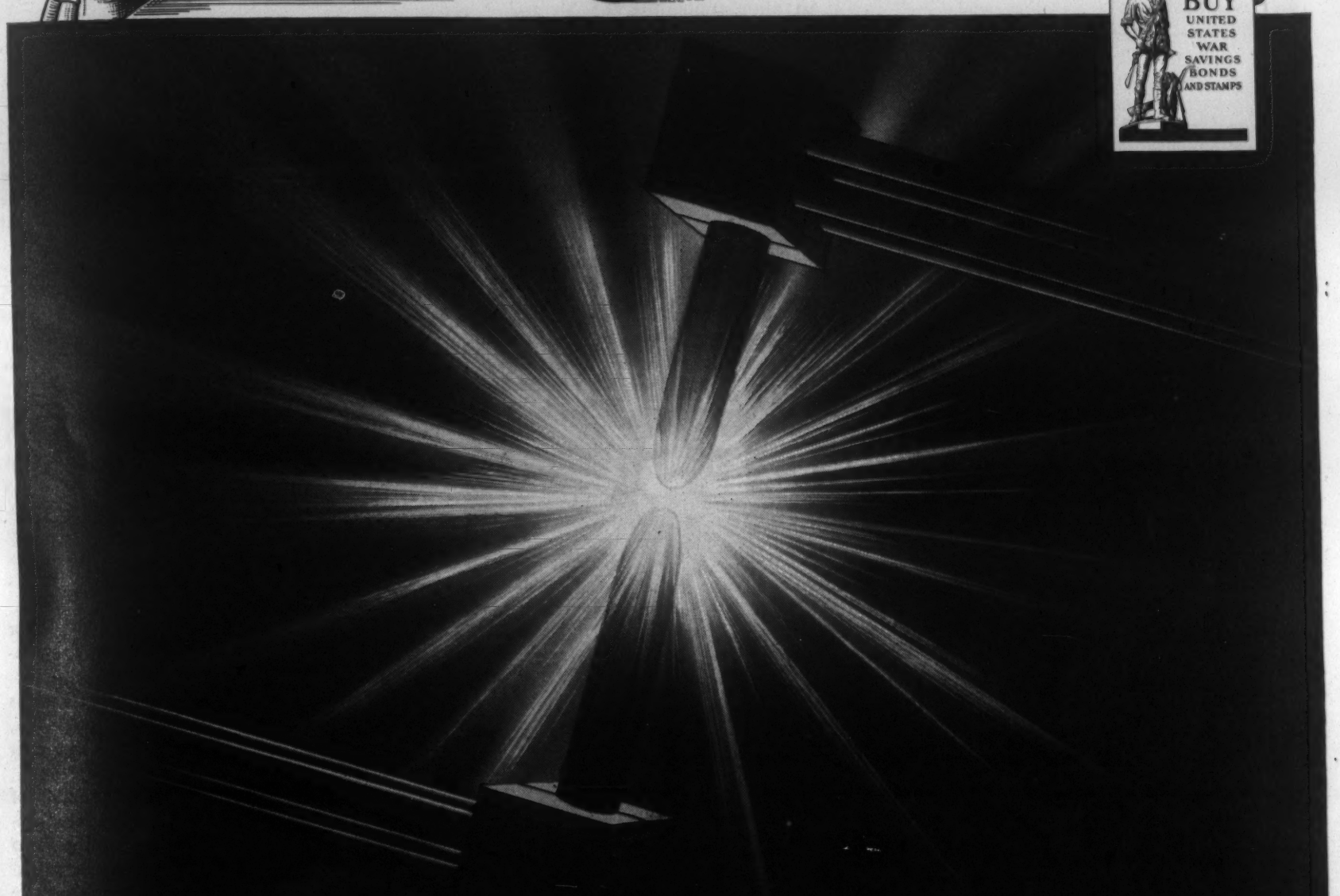
Copper-nickel and antimony were ingotted in the following proportion: 7.5 Sb, 2.0 Ni and 90.5 per cent Cu. Commercial antimony was used plus Monel bar and scrap (Si trace) and B.S. copper ingots. Sand, chill and centrifugal castings were all made. In the case of sand and centrifugal castings, no trouble was observed, the metal being fluid and easy running, most of the castings being poured at about 1200 deg. C. (2190 deg. F.).

When the temperature was lowered to 1150 deg. C. (2100 deg. F.) a skin appeared on the metal surface and the first traces of sluggishness were seen. The metal was clean, and top pouring was employed to insure progressive solidification. In the case of the chill-cast sticks, minute gas or blow holes were present in all the small diameters, suggesting that the alloy solidified so rapidly that air and mold gases were trapped.

This is perhaps one of the reasons for the low physical properties of this material when chill-cast. The contraction of this alloy observed in green-sand castings was approximately 1/10 to the foot. The best results were found when melting in oil-fired and coke-fired forced-draft furnaces.

Examination of the physical properties indicates that in contradistinction to spun phosphor-bronze, the results of this alloy in comparison to sand castings give lower figures, except in the case of the density and Brinell hardness. This alloy appears to have favorable possibilities, especially with thin sectioned sand-cast bushings and gear blanks and heavier sectioned castings made by the centrifugal process.





Sees All-Tells All!

The magic eye of the Spectograph, for which this brilliantly illuminated arc lights the way, literally sees all and tells all about the metals in process of smelting in the various huge batteries of furnaces in Michigan Smelting plants. While the metal is still molten in the furnace, control of the elements in the alloy is now possible. In the most scientific, fastest way, the Spectographic method tells Michigan Smelting technicians of every element and in what quantity, it is present in the sample drawn from the furnace charge. This is only one of the many technical controls developed and used here at Michigan Smelting Division—controls that enable the smelting of non-ferrous alloys to rigid specifications, and of a high quality that never varies.

MICHIGAN SMELTING
AND REFINING
DIVISION OF
BOHN ALUMINUM AND BRASS CORPORATION
DETROIT, MICHIGAN
GENERAL OFFICES • LAFAYETTE BLDG.

NON-FERROUS SCRAP METAL REFINERS FOR 50 YEARS

In an appendix, W. T. Pell-Walpole gives data on the microstructure of the alloy. The microstructure consists of (1) a heavily cored alpha (copper-rich) solid solution varying in the etched condition from dark brown at the cores to pale straw at the boundaries; (2) pools of a second blue constituent (probably the beta of the copper-antimony system with some nickel in solution) at the alpha boundaries. The beta is harder than the alpha and presumably is intended to act as the usual "hard particle constituent" in the bearing.

At high magnification the beta has a marbled appearance which probably indicates a partial completion of the reaction beta-epsilon which occurs at about 450 deg. C. (840 deg. F.). The whole structure is rather porous (pinhole shrinkage cavities), no doubt due to the very long freezing range (about 400 deg. C. — 750 deg. F.). Copper and nickel are mutually soluble, each can dissolve (in equilibrium) about 8 to 9 per cent Sb, and with high antimony content each forms a beta phase, containing less than 30 to 45 per cent Sb. Both beta phases undergo transitions at lower temperatures.

An alloy containing 7.5 Sb and 2 per cent Ni would, on equilibrium, be entirely alpha, but with normal rates of cooling should consist of heavily cored alpha with a certain amount of beta which may be partially changed to epsilon during subsequent cooling. The liquidus of the alloy is approximately 1020 deg. C. (1870 deg. F.) with the solidus approximately 650 deg. C. (1200 deg. F.).

R. F. Hudson, *Foundry Trade J.* Vol. 69, Feb. 11, 1943, pp. 115-117.

Steel Castings from the Converter

Condensed from "Foundry"

It is important that the silicon, manganese and carbon should be reduced to the same level in each heat so that it can be depended upon to have, for example, close to 0.5 per cent each of carbon, silicon and manganese and less than 0.05 per cent of S or P. The proper operation of the bessemer depends upon burning out the carbon, manganese and silicon without burning up too much iron.

To continue the heat beyond the 0.05 per cent level of the carbon means that excess oxygen is used to burn up iron and cause iron oxide to be formed. The excessive oxides require greater quantities of recarburizers and deoxiders.

Most of the silicon and manganese are removed early during the blow with a characteristic greenish flame, while the carbon burns with a yellow flame which changes its color as carbon is reduced below 0.15 per cent. Oxidation should be stopped at 0.05 per cent. To aid the operator in this service an electric eye is used to select the right color.

Blown metal recarburized and ready for pouring must be at the proper temperature for the section thicknesses of the castings to be poured. The temperature is largely controlled by the amount of carbon, silicon, etc., burned out of the converter charge.

Silicon is the most potent source of heat. Each 0.1 per cent of Si burned provides 25,200 B.t.u. which is about 2.5 per cent of the total heat. Then to increase the heat a total of 33 per cent, we must increase the silicon $33 \div 2.5 \times 0.01 = 1.3$ per cent per ton as a ferrosilicon addition.

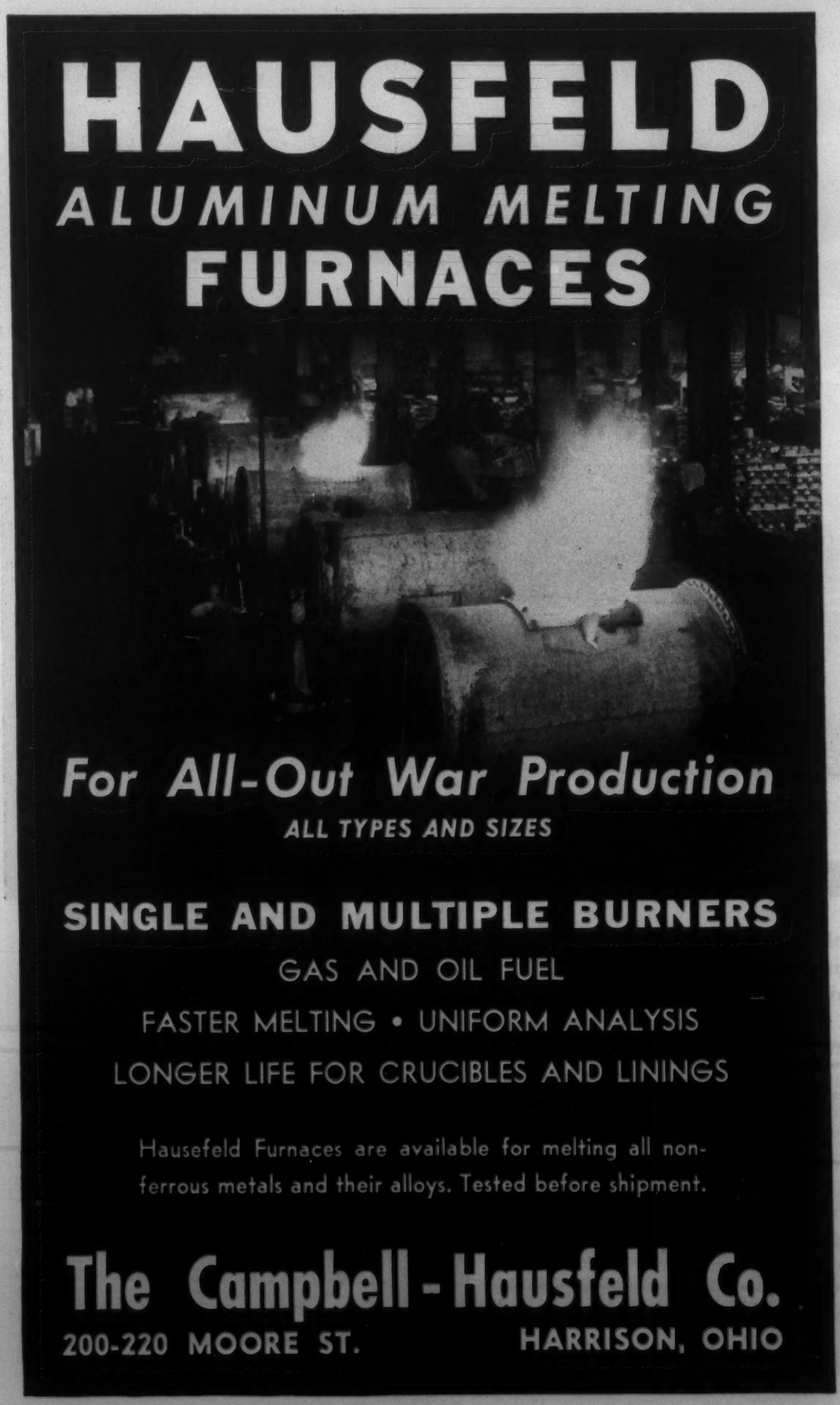
Another method of increasing the temperature of the metal is to tilt the converter slightly when the carbon blow begins so that more free air enters the chamber. This air will burn to CO gas from the metal and develop large quantities of heat. The air required to burn out the impurities of one ton of average cast iron having 3.25 C, 1.75 Si and 0.50 per cent Mn will be about 10,700 cu. ft. at 70 deg. F.

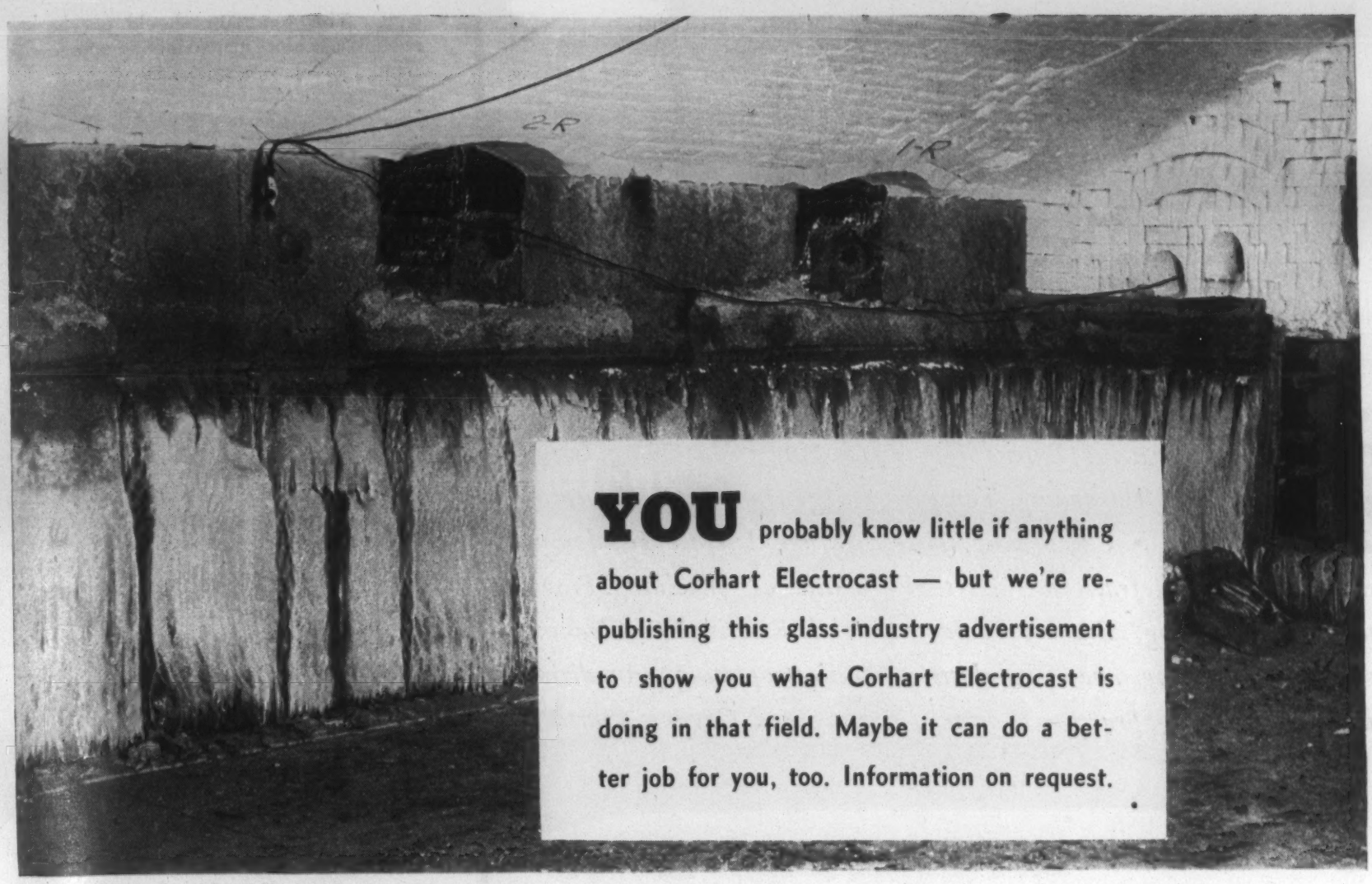
In normally operated SiO_2 (acid) lined converter the slag is siliceous and not too erosive on the lining at the slag line. At the nozzles there is considerable FeO which tends to slag off the SiO_2. This portion must be repaired most frequently.

Phosphorus should be burned out of the metal after the carbon blow and after the addition of lime to make the slag basic. Without plenty of lime the P_2O_5 tends to go back into the iron.

Recarburizing should be done in the ladle. It is not good practice to recarburize in the converter because of the loss of recarburizers to the highly oxidized slag.

—Frederick G. Sefing, *Foundry*, Vol. 71, Feb. 1943, pp. 87, 156-159.





YOU probably know little if anything about Corhart Electrocast — but we're republishing this glass-industry advertisement to show you what Corhart Electrocast is doing in that field. Maybe it can do a better job for you, too. Information on request.

The blocks in the side walls are Corhart Electrocast

Corhart* Electrocast Furnace Produces 122,200 Tons!

BACK IN November, 1937 we published the figures for a "record-breaking" Corhart* Electrocast furnace which had produced 76,446 tons of soda-lime glass, in 556 operating days. At that time we said "When the furnace was let out (on a date set more than a year previously) the operators found that they could have run this record-breaking furnace for possibly another 12 months without predictable danger of failure".

Now this same furnace has just finished another campaign, in which it actually did run "another twelve months"—or a total of over 36 months! During this three year period, it produced 122,200 tons of soda-lime glass.

The operating figures shown below are for that first run, for the last run, and also for an intermediate campaign in 1937-39. We believe these figures will interest every glass manufacturer who is concerned with producing *more glass* at *less cost!*

Corhart Refractories Company, Incorporated, Sixteenth & Lee Streets, Louisville, Ky.

	CAMPAIGN 1935-1937	CAMPAIGN 1937-1939	CAMPAIGN 1939-1942
Total Days of Life	708	710	1,100
Total Operating Days	556	456	835
Square Feet Melting Area	1,000	1,000	1,000
Total Glass Delivered (Tons)	76,446	62,638	122,200
Tons of Glass Melted Per Day (based on total life)	107.9	88.2	111.0
Tons of Glass Melted Per Day (based on operating days)	137.4	137.3	146.3
Square Feet Melting Area Per Ton of Glass (based on total life)	9.2	11.3	9.0
Square Feet Melting Area Per Ton of Glass (based on operating days)	7.2	7.2	6.8
Tons of Glass Per Square Foot of Melting Area Per Life of Furnace	76.4	62.6	122.2

*Not a product, but a trade-mark.

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Die Casting • Powder Metallurgy • Drop, Hammer and Upset Forging • Press-Forming, Drawing, Extruding and Stamping • Machining, Grinding and Polishing • Hardening, Tempering, Age-Hardening, Annealing and Malleableizing • Carburizing, Nitriding and Surface Hardening, Heating Furnaces, Refractories, Fuels and Auxiliaries • Welding, Flame-Cutting, Hardfacing, Brazing, Soldering and Riveting • Cleaning, Pickling, Degreasing and Sandblasting • Electroplating, Anodizing, Galvanizing, Metal-Spraying, Coloring, Buffing and Organic Finishing

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Surface Treatment of Magnesium

Condensed from "Proceedings," Amer. Electroplaters' Society

Steps in cleaning magnesium include solvent or emulsion degreasing, and alkaline cathodic or soak cleaning, followed by hot and cold water rinsing. A suitable alkaline cleaning solution contains 4 oz. per gal. trisodium phosphate, 4 oz. per gal. sodium carbonate, and 0.1 oz. per gal. of soap or wetting agent. The soap is omitted in electrolytic cleaning.

Oxide layers, graphite base lubricants, and other water-insoluble or non-emulsifiable substances cannot be removed by the above procedures. Cleaning in a solution of 1.5 lbs. per gal. of chromic acid at 190 to 212 deg. F. for 1 to 15 min. will remove the latter types of contaminants. Chloride and sulphate content of this pickle must be low.

Wire brushing, or sand or shot blasting, may be used for cleaning, but the surface so produced has poor corrosion resistance and must be removed by pickling. A satisfactory pickling procedure consists of 10 to 15 sec. immersion at room temperature in a bath containing 8 parts concentrated nitric acid, 2 parts concentrated sulphuric acid, and 90 parts water, by volume. This procedure should not be applied to machined parts since an appreciable amount of metal is removed.

Decorative finishes include: (1) Mechanical finishes such as polishing and buffing, sandblasting, etc.; (2) chemical finishes such as bright and mat etched finishes and dyed oxide finishes; (3) electrochemical finishes such as dyed anodic coatings and electroplated coatings.

With the exception of the electroplated coatings, these finishes require the protection of a clear lacquer. They have little protective value and are suitable only in indoor atmospheres.

Protective Finishes

The following protective finishes are described: (1) Chromium-pickle, or Dow treatment No. 1, is used primarily to protect parts during shipment and storage. It consists of a 15-sec. to 2-min. dip in a solution containing 1.5 lbs. per gal. of sodium or potassium dichromate and 1.5 pints per gal. of concentrated nitric acid at room temperature. About 0.001 in. of metal is removed.

(2) Chromium sulphate, or Dow treatment No. 11, produces a low dielectric strength film. The treatment consists of a 30 to 60-min. immersion in a solution of 6 per cent magnesium sulphate and 4 per cent potassium dichromate at room temperature.

(3) Dichromate, or Dow treatment No. 7, is the most widely used final chemical treatment. It affords maximum protection, good paint adhesion, and little or no dimensional change.

The parts are immersed for 5 min. at room temperature in a 15 to 20 per cent hydrofluoric acid solution, rinsed in cold water and dipped for 45 min. in a boiling solution of 1 lb. per gal. of sodium, potassium, or ammonium dichromate. Directions for control of these baths are given.

(4) Galvanic anodize, or Dow treatment No. 9, is used on Dowmetal M (magnesium + 1.5% Mn). The treatment consists of the hydrofluoric acid dip used in Dow treatment No. 7, followed by at least 30 min. anodizing at 120 to 140 deg. F. in a solution of ammonium sulphate, 4 oz. per gal.; sodium dichromate, 4 oz. per gal.; ammonia, ⅓ fl. oz. per gal.

The iron or steel tank used to contain the bath may form the cathode. The current density should not exceed 10 amp. per sq. ft. At least 70 amp. minutes of treatment are required. Control of the bath is described.

(5) Modified alkaline dichromate of Dow treatment No. 8 is similar to (4); following the hydrofluoric acid dip the parts are boiled in the sulphate-dichromate-ammonia solution for 45 min., then dipped for 5 min. in a boiling 1 per cent solution of arsenious oxide.

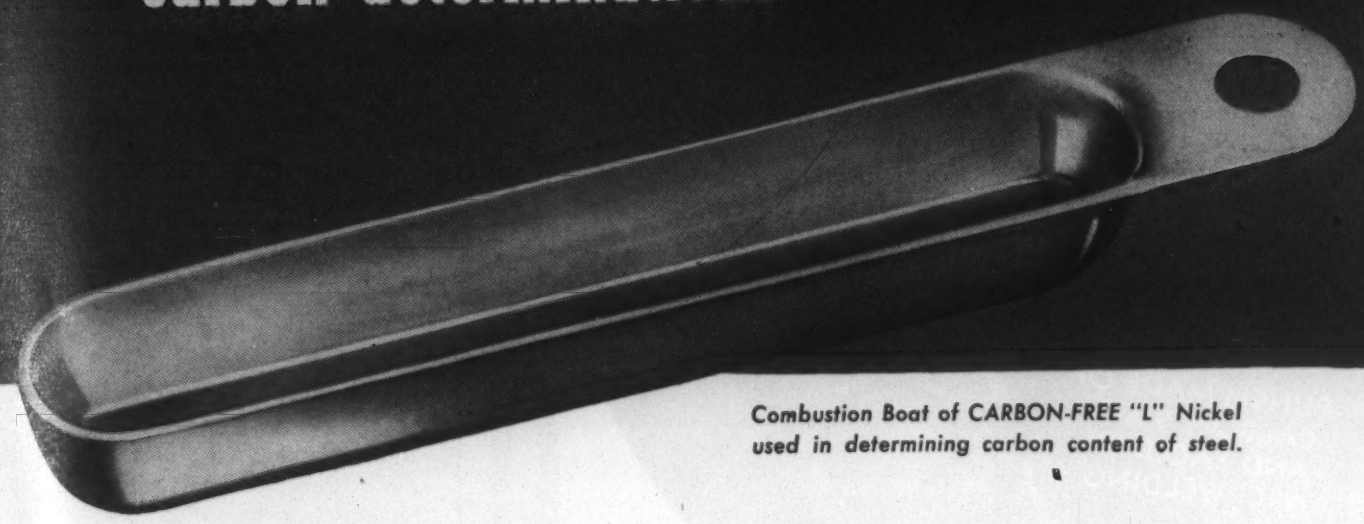
(6) Sealed chromium-pickle, or Dow treatment No. 10, is a modification of the No. 1 treatment. After the No. 1 treatment the work is immersed for 30 min. in a boiling solution of 1 lb. per gal. of sodium dichromate.

(7) Anodic, or Dow treatment No. 13 and Navy PT-13, consists of a hydrofluoric acid pre-dip followed by anodic treatment in a solution of trisodium phosphate

PAGE for the Record

AT 2200°F—IN A STREAM OF PURE OXYGEN—

Nickel combustion boats do 100 to 150 carbon determinations



Combustion Boat of CARBON-FREE "L" Nickel used in determining carbon content of steel.

IN determining the carbon content of steels, combustion boats must meet conditions that are unusually severe.

The boats must be made of a metal that is carbon-free, to eliminate the error that might otherwise creep in from this source.

They must also be able to withstand a temperature of 2200° F. in an atmosphere of pure oxygen.

These requirements are fulfilled admirably by carbon-free Nickel strip. Boats of carbon-free Nickel do *100 to 150* carbon determinations before replacement is necessary.

As the steel sample fuses completely at the temperatures maintained during the determination, the boats . . . to obtain the utmost service . . . are protected from direct contact with the molten metal by a layer of carbon-free alundum. The sample of steel is put in a shallow trench scooped in the alundum.

Upon completion of the assay, the fused sample disseminated throughout the alundum can be readily removed from the boat.

The details of this use of Nickel strip are published as data of interest to engineers working on similar problems, as well as those planning for the future.

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL STREET, NEW YORK 5, N. Y.

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REPAIR *Worn* DIES
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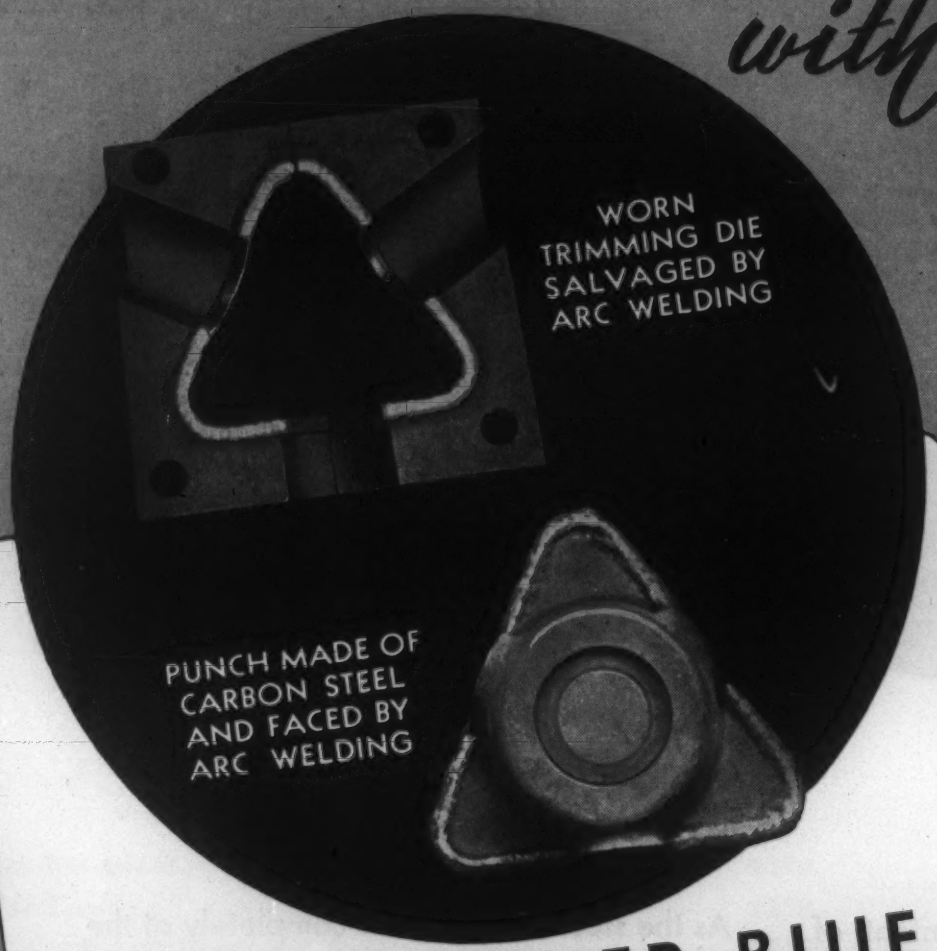

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and sodium dichromate.

Special uses and limitations of each process, relative abrasion resistance of the films produced, and their relative protective values are discussed. These chemical finishes serve as bases for protective paint coatings.

—H. K. de Long and W. H. Grosa, *Proc. Am. Electroplaters' Soc.*, 1942, pp. 110-117.

Carbide Tools on Turret Lathes

Condensed from "Screw Machine Engineering"

The screw machine department at the River Works Plant of the General Electric Co. has been using cemented carbide tools on hand turret lathes for 12 years. Primary problems were to select proper feeds and speeds, correct grades of Carboloy, the best tool grinds and the proper method of grinding. Some of the older machines did not have high enough spindles. To overcome this, those strong enough were equipped with two speed motors.

Five grades of Carboloy were selected: 78, 78B, 44A, 883, and 905. Cemented carbides are used on 75 per cent of the single point cutting and forming tools. Of these, 80 per cent are ground from standard tools.

One of the first and most successful applications is the roller turner tool. Much of the work consists of machining bolts and body bound studs. Difficulty with the interrupted cut which occurs when turning hex bar stock was overcome and there is no trouble with either a grade 78 or 78B. The average tool life per grind when taking maximum chip is 180 to 190 linear inches.

On a 2½-in. turret lathe, the maximum chip is ⅝-in. On the 3½-in. machine, it is ¾-in. A ground-in chip breaker is used. Everything must be perfectly rigid, especially on hex bars where there is a long cut and the bar is being fed out 6 to 12 in. It is advisable to break down the bar with a heavy 45 deg. chamfer to start the tool. The tool is set ahead of the rolls ⅛ in. and fed by hand on this first ⅛ in. at one-half of normal speed. Then the machine is brought up to speed and the automatic speed engaged.

The use of carbide tools has increased production 50 to 60 per cent. With high-speed steel turning tools, an alloy steel 1¼ in. x 7 in. hex bolt, made from 2-in. stock, was turned at 48 surface feet with an 0.008 in. feed. With Grade 78 Carboloy cemented carbide, it is turned at 200 surface feet with 0.006 in. feed.

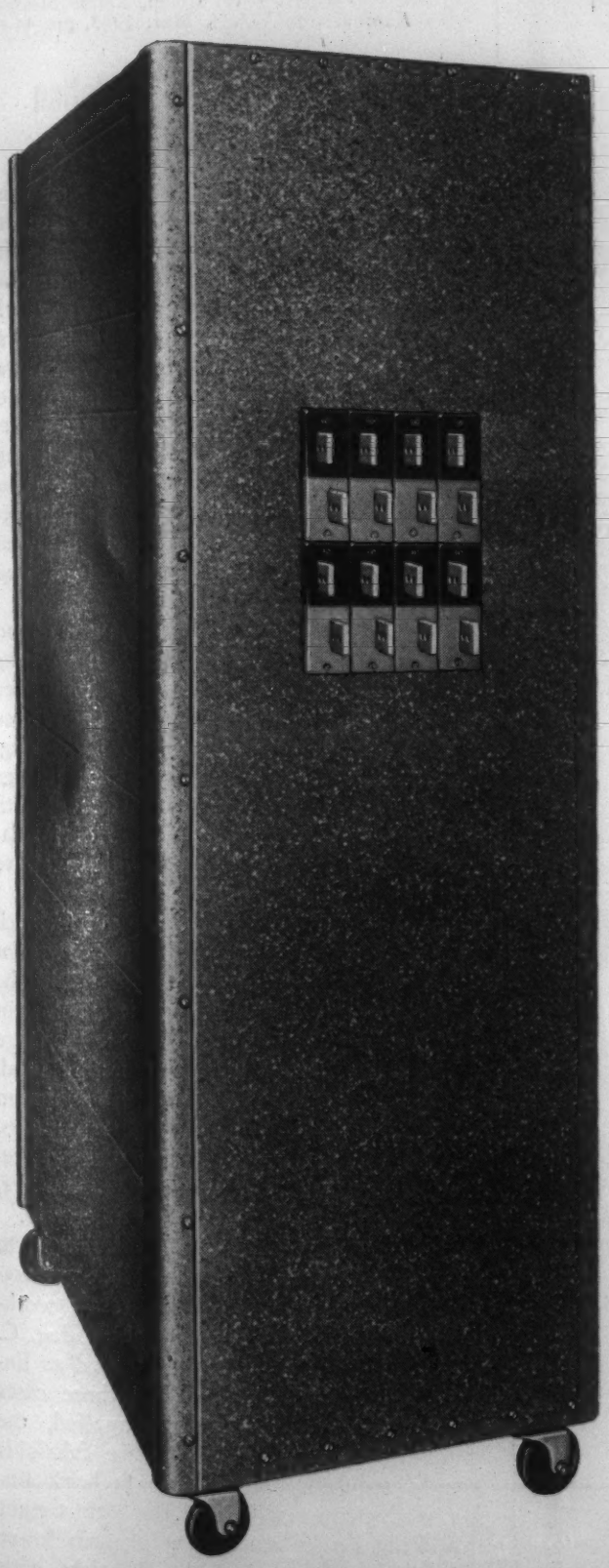
On the finish machining of stainless steel bushings, which must be held to a tolerance of 0.001 in. on diameter, grade 883, a straight tungsten carbide gives excellent results — approximately 300 linear inches per grind. The bushings run between 250 and 300 surface feet, when formerly the maximum was 65.

A 20.1 mixture of soluble oil is a satisfactory coolant on all of the machines except the stainless steel bushing job. Because these parts have a high Rockwell, a tough scale, and require a high finish, a sulphur base cutting oil is used.

Many other jobs in the shop use Carboloy tipped boring tools, turning tools,

MULTI-PLATER

GREEN MULTI-PLATER MODEL 86



42" wide, 24" deep
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ALL IN ONE CABINET--

the MULTI-PLATER provides eight (8) separate selenium rectifier sections each having an output capacity of 6 volts 500 amperes.

For quick, simple installation and mobility, MULTI-PLATERS are mounted on casters.

Separate output terminals make it possible to connect each rectifier section to a separate tank, or several sections may be added together for higher voltage or greater current capacity, or *all* the sections may be grouped together in a single bank.

When sections are used individually, or in groups, there are *several hundred* possible combinations; for example: If all eight sections are interconnected any one of the following outputs may be obtained:

6 volts 4000 amperes,
or 12 volts 2000 amperes,
or 24 volts 1000 amperes,
or 48 volts 5000 amperes.

Standard MULTI-PLATERS provide internal connections for operation from 220, or 440 volt 60 cycle 3 phase supply.

MULTI-PLATERS can be furnished for other supply voltages.

MULTI-PLATERS of lesser capacity than Model 86, as illustrated, are also available.

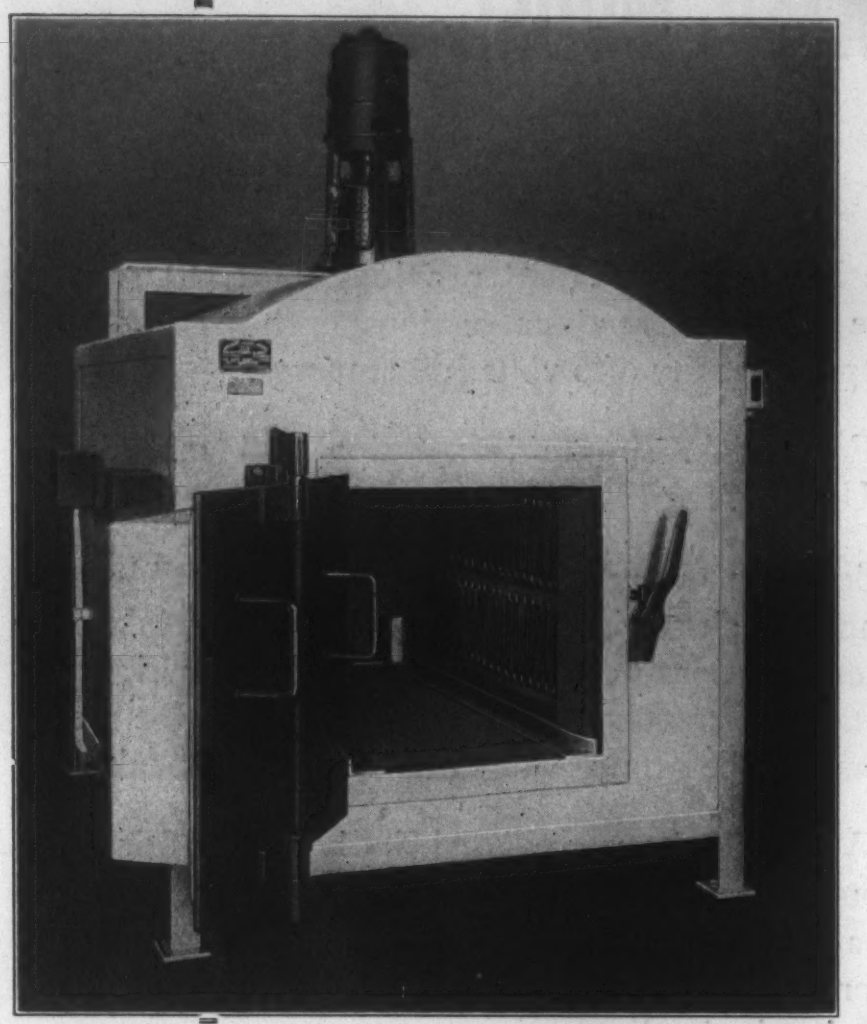
Write Dept. W for illustrated booklet.

W. GREEN ELECTRIC CO., INC.

ESTABLISHED 1892

Builders of SELECTRO-PLATERS and all types of rectifier equipments.

Green Exchange Bldg., 130 Cedar St., New York



AO2444 Furnace. Rating 30KW. Accommodates Wheeled Container 21" wide x 36" long x 17" high. Built in many standard sizes.

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Industrial Furnaces for All Purposes

facing tools, reamer blades and reamers. After a proper set-up, success depends upon the grinding. The average operator cannot do it. In this shop, the tools are ground in a central area, being rough-ground dry with a 60-grit silicon carbide wheel and finish-ground on a 120-grit diameter wheel. A mixture of 2 teaspoonsful of tri-sodium phosphate to one quart of water gives good results in finish-grinding. Operators must be thoroughly trained.

—Charles W. Coffin, *Screw Machine Engineering*, Vol. 4, Mar. 1943, pp. 44-47.

Practical Furnace Insulation

Condensed from "Metallurgia"

Developments in the technique of what has come to be known as "hot face insulation" have introduced new economies and advantages, one of the most striking of which is the saving of time. Formerly the backing for the furnace lining was of insulating brick or powder, which was equivalent to enclosing the entire furnace in another furnace, and the heat generated has to raise the temperature of lining, insulation and the stock itself. One thousand standard 3-in. firebricks would need 2,000,000 B.t.u.'s to raise their mean temperature by 1,000 deg. F. (538 deg. C.).

In a furnace operating upon a short cycle the time required to reach working temperature will be strongly influenced by the thermal capacity of the lining. Those operating at temperatures above 950 deg. C. (1740 deg. F.) require thick linings to protect backings of diatomaceous earth or other low temperature types of insulation, which suffer severe shrinkage above that range.

In some cases a 4½-in. lining of firebrick would be satisfactory from the viewpoint of safety, but such a lining would be unstable mechanically, since it should not be "tied" to a backing of low-temperature bricks. A 9-in. lining is therefore used, and this may be regarded as the minimum thickness of refractory for most purposes. Backing insulation will save fuel by preventing dissipation into the atmosphere, but will probably increase the time cycle.

Hot-face insulation is calculated to overcome these difficulties. High-temperature insulators usually have a safe working temperature in excess of 1300 deg. C. (2370 deg. F.), and could be used as linings for general service. In those cases where hot-face insulation is applied, the thermal capacity of the furnace fabric is greatly reduced. The dense firebrick lining is dispensed with and the light-weight insulating bricks reach a very much lower mean temperature than do firebricks with an insulating backing. The heat loss through the high-temperature insulator wall is only slightly higher than that through an insulated firebrick wall, and less than half that through an uninsulated firebrick wall. The heat content of the hot-face insulated wall is enormously less than that of either of the others.

Lack of mechanical stability would prevent the satisfactory use of high and low-temperature insulations in conjunction. There are instances of furnaces previously lined with firebrick and subsequently adapted to hot-face insulation in which

Now TERMINAL TUBES ARE BRAZED TO STEEL ENCLOSURES FOR MARINE SERVICE

WITH

EASY-FLO

Easy-Flo — the low-temperature silver brazing alloy — is now virtually standard on marine construction for joining terminal tubes to switch boxes, lighting fixtures and other terminal boxes. It provides everything the job calls for—speed, reliability and low cost in making high strength, water-tight joints that have the ductility to stand up under the severe vibration and shock of heavy gun fire.

The job is done by preplacing a ring of Easy-Flo wire in the joint assembly as illustrated. This preplacing of the alloy is an important factor in the fast production obtained and also gives close control of the amount of alloy used.

Easy-Flo rings are available for all standard terminal tube sizes.

NEW EASY-FLO "RINGS" BULLETIN

It explains the brazing procedure fully and tells the ring size required for different sizes of terminal tubes. Write for a copy of this new Easy-Flo "Rings" Bulletin today.

ARMY E NAVY
1ST AWARD August 1942
2ND AWARD February 1943

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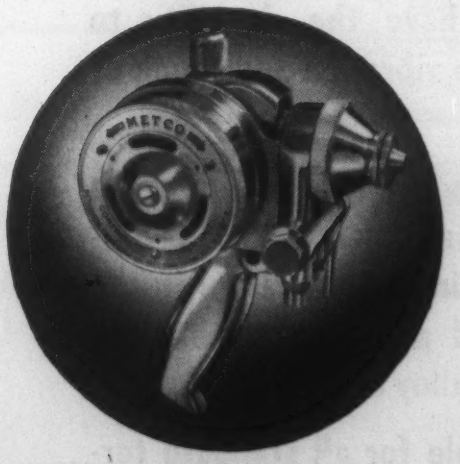
Agents in Principal Cities. In Canada: HANDY & HARMAN of Canada, Ltd., Toronto

60,000 lbs. of Salvage

with 50 lbs. of Sprayed Iron!

METCO Metallizing Gun restores mis-machined surfaces without removing work from the lathe



ONLY THE METCO Type 2E Metallizing Gun is equipped with the Power Control Governor. Built into the turbine, it automatically controls and stabilizes wire feed at *all* speeds . . . eliminates gear changes . . . avoids obsolete needle valve control which restricts air flow and reduces power at low speeds. For maximum efficiency and economy, insist on the Power Control Governor. Write for Bulletin 42A.

HOW MANY TONS of fabricated metal and hundreds of man-hours now wasted through mis-machining could *you* save with a METCO Metallizing Gun? 60,000 lbs. was the amount of cast iron salvaged by a large ordnance plant *on one job alone* when a bearing surface on this 17 ft.-long centrifugal mold was badly gouged in turning. Using only 50 lbs. of SPRAIRON, and relatively unskilled female help, the mis-machined area was built up to specifications in less than a day—*without removing the mold from the lathe.*

Similar remarkable savings are experienced wherever METCO Metallizing is reclaiming worn or mis-machined parts—regardless of their size or analysis. Find out what this modern maintenance and production process can do for *you* by getting in touch with METCO now! Ask also for the latest issue of METCO NEWS—the Nation's most authoritative and widely read magazine on metallizing.

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TEN YEARS OF PROGRESS

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WORLD'S FINEST METALLIZING EQUIPMENT

the time required to reach working temperature has been reduced by 80 per cent. Accuracy of temperature control has been greatly facilitated, with unusually even distribution of temperature. Cooling can, when required, be carried out with great speed.

In furnaces working at very high temperatures or under very severe conditions, high-temperature insulating bricks may be used as backing to a suitable thickness of firebrick or silica brick. They may usually be bonded or tied for stability, since their thermal expansion characteristics are fairly similar. At very high temperatures, however, the effect of the insulating backing may be to overheat the lining.

—John W. Dawson, *Metallurgia*, Vol. 27, No. 161, Mar. 1943, pp. 177-180.

Savings By Induction Heating

Condensed from
"Canadian Metals and Met. Industries"

High frequency induction heating is being used in a number of Canadian plants engaged on war production, with important savings in man hours, in skill of operators required, in heat-treating equipment, and in floor space. The John Inglis Co., Ltd., employs it for hardening, annealing, heating for bending, and the making of shrink fits in the production of Browning and Bren machine guns, and the Boys anti-tank rifles.

The hardening of four areas on the body of the Boys anti-tank rifle by torch consumed 66.94 hrs. per hundred pieces. With suitably designed induction coils the work was accomplished in 9.03 hrs. per hundred components, 2 inside and 2 outside coils being used. In this way a hardness reading on the outside of the body indicates the hardness achieved on the inside surfaces also.

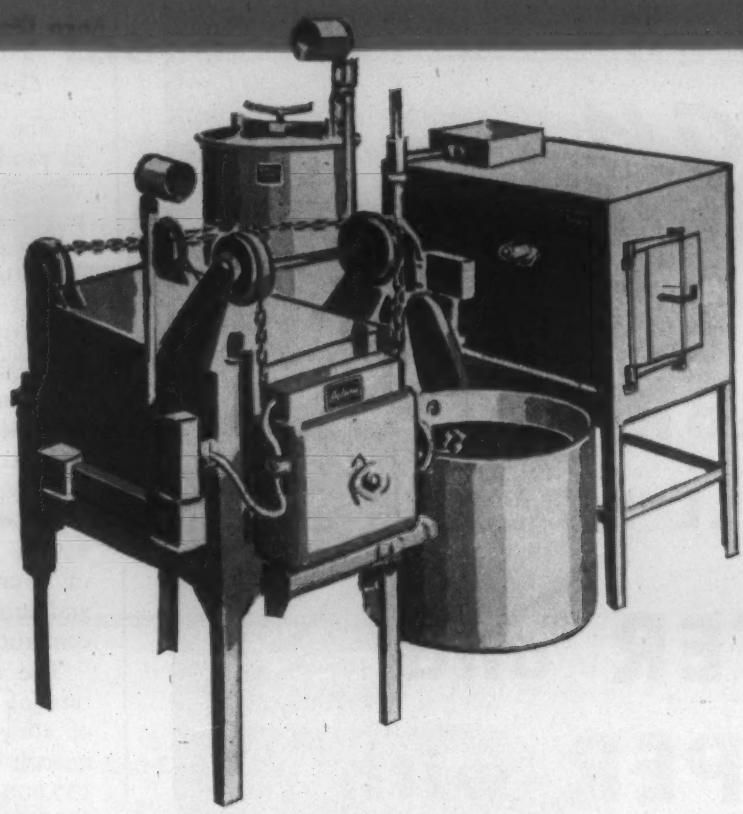
Hardening of rivet heads, formerly accomplished in a lead pot, is now done in an elongated induction heating coil, 3 sec. being required as against two minutes in the lead pot. The heated rivets automatically drop into an oil quench below the conveyor belt.

Closer control of hardening operations and cleaner work are shown by induction heating. Localization of the hardening is illustrated in a top plate for the Browning machine gun in which a catch at one end must be hardened, while the corners must be kept soft enough for subsequent drilling.

Annealing operations are not as common as other applications, but can be carried out similarly. In a shrink fit operation a collar is placed in a suitable coil, heated for 24 sec., the barrel is then dropped in, and the assembly allowed to cool.

On 23 items the equipment saving was five lead pots. Estimated savings on four Bren components annually amount to 4,026 hrs. Estimated savings on five Boys components, fourteen Browning components on contract are 33,076 hrs. and 17,190 hrs. respectively. Dollar savings are estimated at $27,146 on the 23 components.

—*Can. Metals & Met. Inds.*, Vol. 6, Apr. 1943, pp. 33-46.



A double play in the toolroom . . .

from HYDRYZING to Quench Tank to CYCLONE!

An unbeatable combination, supplied complete by Lindberg, teams up to give you the most efficient and economical setup for the precision heat treatment of tools and dies.

. . . **from Hydryzing,** the expense of costly cleaning operations is eliminated because the neutral, controlled atmosphere prevents scale, decarb and carburization. The clean surface of the Hydryzed parts assures a full, uniform hardness when the parts are transferred

. . . **to the quench tank,** insuring the maximum life for tools and dies. Incidentally, with toolroom setups, Lindberg can supply quench equipment to meet any specifications, complete with tank, coolers, pumps, storage tanks and temperature controls.

. . . **to the Cyclone** Toolroom Tempering Furnace any tool or die can be entrusted with complete confidence. The parts are heated by 100% forced convection with a uniformity and control accuracy which allows temper tolerances of ± 1 Rockwell "C."

Thus is precision heat treating accomplished—Hydryzing insures the time and money put into the machining of the tool or die and the Cyclone puts it into long, productive service with the specified toughness to carry through.

You can have all the advantages of a winning team—write TODAY for Bulletin 94 on Hydryzing and Bulletin 62 on the Cyclone Toolroom Tempering Furnace.

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CYCLONE for accurate, low-cost tempering and nitriding
HYDRYZING for scale-free and decarb-free hardening

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VAPOR BLAST Abrasive Cleaning is making production and economy records in many of the country's leading metal working plants!

Using SAND for abrasive cleaning—"Water to eliminate Dust—Chemical to prevent Rust", the VAPOR BLAST method is getting MORE work done. . . . Effectively cleaning all types of metal surfaces, castings, welded parts, plates, sheets—even preparing precision parts for X-Raying or Magna-Fluxing . . . And doing it at low costs unheard-of in any previous operations.

Let us show you how VAPOR BLAST can speed up YOUR metal cleaning operation, reduce production costs. Write for details, or call on a Vapor Blast Engineer for money-saving suggestions on your cleaning problems.

VAPOR BLAST MANUFACTURING COMPANY

333 S. 16th Street Milwaukee, Wis.

Welding Aero Propeller Blades

Condensed from "Welding Journal"

The utilization of airplane engine power in production of faster planes is dependent upon improved performance of the propellers. The hollow steel propeller permits savings in weight that increase with propeller diameter because (a) weight increases approximately as the square of the diameter as against the cube for solid propellers. Smaller shank diameters are also required than for ligther materials (Al alloy and wood) hence hub size and weight is reduced.

Hollow steel blades are manufactured in sizes up to 18 ft. basic diameter for use in 3 or 4 blade propellers in engines of over 2000 h.p. The greater rigidity and erosion resistance of the hollow steel construction are added advantages.

The starting material for the manufacture of the blades is 9/16 in. thick plate of alloy steel which after a 1650 deg. F. quench and an 1170 deg. F. draw has 135,000 to 165,000 lbs. per sq. in. ultimate, 125,000 to 160,000 lbs. per sq. in. yield, 45 to 60 per cent red. of area, 15 to 20 per cent elongation, 75,000 lbs. per sq. in. endurance limit, and Rockwell C hardness 26 to 33.

The steps in the manufacture include many milling operations to shape and taper the plates prior to cold forming. One step requires the milling of the entire plate surface to remove decarb and imperfections. After forming, the blades are welded on the outside edges with atomic H_2 torch; on the outside shank seam and cuff retaining ring, Unionmelt welding is used; for the inside shank seam, oxyacetylene welds are made.

Jigs are used for all welds, the blades are stress relieved at 1200 deg. F. after Unionmelt welding and preheated for gas welds of the inside seam. In some cases the piece after welding is buried in flake mica to reduce cooling rate. Inside of the blade copper brazing is used to smooth the inside weld surfaces after the blade has been stress relieved and cleaned.

Copper wires are placed in the inside and melted down through the gradual passage of one edge at a time between two pairs of oppositely located and insulated gas burners. Heating for hardening is performed in the same type of furnace and atmosphere as used for normalizing, each blade being placed in an individual Nichrome muffle. The atmosphere is generated through combustion of a 6:1 mixture of air and natural gas. Water vapor and CO_2 are removed, and the final product contains 6 to 8 CO, 10 to 12 per cent H_2, no CO_2 and a trace of H_2O (dewpoint —20 deg. C. [—4 deg. F.] or less).

Final straightening and quenching is effected in a die, cooled internally with water. The blade is forced to take die contour through internal pressure of nitrogen gas. The thin sections of the blade are quenched by contact with the die while the shank end receives an external water quench. Finishing and inspection are quite involved steps in which each blade receives an X-ray and four Magnaflux tests.

The steel for propeller blades is purchased on a fusibility specification which

Here at last . . . the answer to Corrosion Problems

ANTI-CORRODE

New Liquid Safeguard Developed by Cities Service

Anti-Corrode, Proved Perfect by Months of Laboratory Testing, Meets Severest Corrosion Requirements. It's Easy, Economical to Apply.

After months of laboratory research and rigorous service tests, Cities Service takes pride in announcing the development of a new and *completely effective* corrosion preventive—Anti-Corrode.

This new liquid safeguard, by virtue of its special properties, and its reasonable cost, is hailed by many engineers as a perfect answer to the vital problem of metal conservation that American industry faces today.

METHODS OF APPLICATION

Anti-Corrode can be applied to raw stocks, finished parts, or to complete machines during storage, assembling or shipping. It is easily applied by dipping, brushing, rubbing, hand or power spraying—and provides a safe film which does not harden, become brittle or crack.

WEATHERING

Anti-Corrode is not affected by rain, salt air, oxygen bearing moisture, etc.

ODOR

Anti-Corrode has no disagreeable odor.

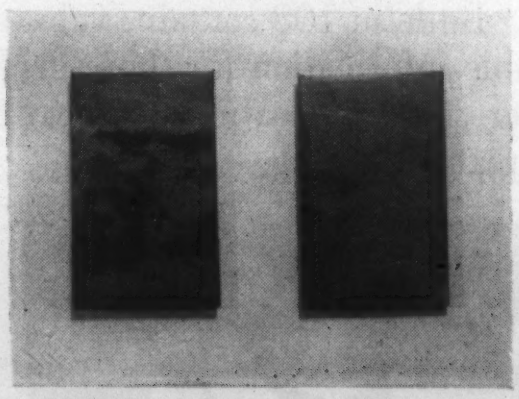
CHEMICALLY INERT

Anti-Corrode is chemically inert to ferrous or non-ferrous metals. Therefore, it can cause no injury to any metal to which it is applied or with which it may be brought in contact.

FINGER STAINS

Surfaces coated with Anti-Corrode can be handled freely without danger of rust spots caused by hand acid.

ANTI-CORRODE MEETS U. S. NAVY TEST



BOTH STRIPS of freshly ground steel pictured here were immersed for 20 hours in a 3% salt solution. Strip on left was untreated; strip on right, coated with Anti-Corrode, shows no trace of rust. (Even after 90 hours of immersion Anti-Corrode coating still resisted rust.)

A LUBRICANT, TOO

Anti-Corrode is compatible with drawing compounds; there is no need to remove it from metal about to be drawn, stamped or otherwise formed.

IDEAL FOR MANY USES

Anti-Corrode can be used on almost every kind of metal or metal equipment—*indoors or outdoors*. Fencing, piping, tubing, wire, wire mesh, girders, sheet metal, metal stock, machinery, trucks, spare automotive parts, tools, metal containers—all need the protection of this new corrosion preventive.

ECONOMICAL

In accordance with regular U. S. Navy Test procedure, Anti-Corrode proved far superior to other leading anti-rust compounds costing as much as *25% to 40% more per gallon.*

Whatever metal equipment you may have, you owe it to yourself to investigate the money-saving advantages of Cities Service Anti-Corrode. (One gallon of Anti-Corrode protects approximately 1200 square feet of sheet metal.) Send the coupon below for further information on how to obtain an adequate sample of Anti-Corrode FREE.

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Gentlemen: I'd like to test Anti-Corrode on my own equipment FREE OF CHARGE. Send me the details.

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SHREVEPORT, LA.

In the Production of Shells, *Amsco Alloy Is Doing Its Bit*

There is going to be plenty of good American shells for the Japanazis. While Amsco Alloy is not used in the shells themselves, it is performing essential service as parts for heat-resisting equipment used in the production of shells, bombs, ordnance, tanks and airplane engine parts.

Wherever heating or heat treatment is employed in armament making, Amsco Alloy will be found in active service, not only in new Defense Plants, but also in the converted factories of makers of trucks, stoves, washing machines, cotton gins, lawn mowers and even needles.

Heating and heat-treating equipment must be highly heat-resisting and otherwise built to withstand the rigors of continuous operation. Long before this war started, Amsco Alloy had proved its ability to withstand, for long periods, high temperatures, frequent or drastic temperature changes, and corrosion.

Naturally, armament makers took prompt advantage of Amsco's engineering, metallurgical and field experience, and Brake Shoe's extensive research and experimental facilities.

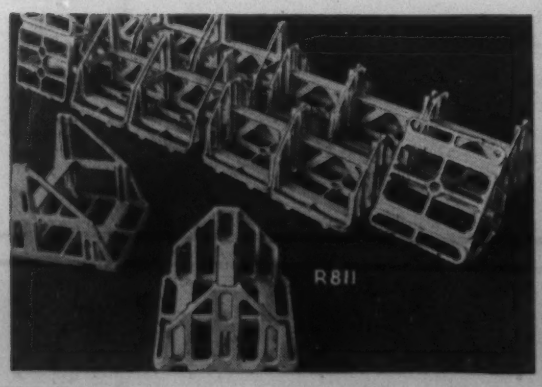
Applications of Amsco Alloy in the war industries include furnace structural parts, containers, trays, muffles, fixtures and supports of many types for holding work of all kinds. *There is a grade of Amsco Alloy for every furnace condition of heat and corrosion up to 2100° F.*

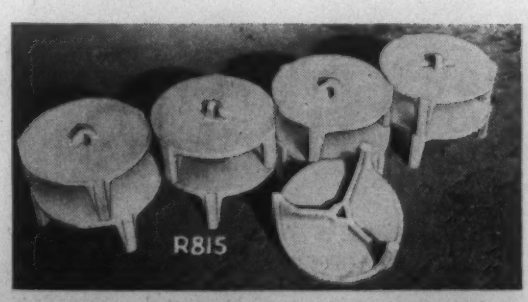
Bulletin 108 contains valuable information for those interested in heating or heat treatment.

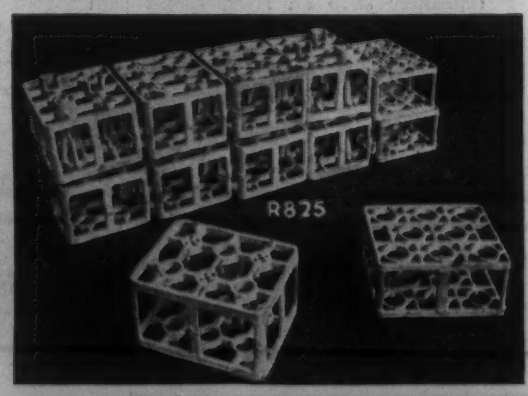
R-811 Amsco Alloy fixtures for holding tank and army truck gears during gas carburizing in muffle type furnace.

R-815 Hardening trays for small parts; used in carburizing furnace.

R-825 Fixtures for carburizing tank shafts.







Amsco
AMERICAN MANGANESE STEEL DIVISION
Chicago Heights, Illinois

AMERICAN Brake Shoe COMPANY

FOUNDRIES AT CHICAGO HEIGHTS, ILL.; NEW CASTLE, DEL.; DENVER, COLO.; OAKLAND, CALIF.; LOS ANGELES, CALIF.; ST. LOUIS, MO.
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indicates the behavior of the weld metal under the atomic hydrogen torch. No difficulty is experienced with atomic hydrogen welding of steels which pass the fusion test; it is also possible to use the metallic arc for welding steels rejected by the fusion tests, but the atomic hydrogen torch is preferred because of the better control of contour of the weld inside the blade.

The main factor affecting the weldability as indicated by the fusion tests is thought to be the sulphur content of the steel. A study of the type of inclusions resulting from various deoxidation practices is in progress and information to date indicates the eutectic type sulphide inclusions resulting from insufficient aluminum addition are mainly responsible for poor weldability.

—C. A. Liedholm, *Welding Journal, N. Y.*, Vol. 22, Mar. 1943, pp. 165-172.

Welded Aircraft Jigs and Fixtures

Condensed from "Aeronautical Engineering Review"

It is natural that the airplane industry should accept arc welding as the means of fabricating the tools required to assemble the airplane, although unfortunately the industry has not been able satisfactorily to adapt arc welding to the fabrication of the airplane itself.

The airplane is divided into many subassemblies, and this means many jigs and fixtures for each individual part. This tooling problem is complicated by the fact that the design of the airplane is usually going on simultaneously with the building of tools and templates, involving last-minute changes in tools. The problem is, of course, time.

The bottleneck in this accelerated program is always the machining of jig structure and fittings. While rough structure fabrication is rapid, plant and "outside shop" machining facilities are quickly overloaded.

When original wooden jigs were replaced by metal, used pipe or structural steel was welded for the rough structure. Pads were attached and machined. The base was usually milled, and a notch cut for the airplane part, tolerances being of the order of ± 0.010 in. Fittings were located on the frame, checked, screw-fastened to the base, and double doweled.

In developing a new design procedure there were three objectives: (1) Minimize machining, (2) minimize tools required for jig fabrication, and (3) minimize time required for jig fabrication. The problem was to make tools with a tolerance of ± 0.010 in. without machining.

So successful was the new procedure that the only tools required by the jig shop were welding machines, surface plates, surface disc grinders, metal cutting band saws and drill presses. Attachment of pads was accomplished by means of a spherical bushing developed by the shop, consisting of a hollow bolt with a spherical head. After locating, the bolt is fastened in place by a tack weld. This fitting is also used as a leveling lug, eliminating necessity for base machining.

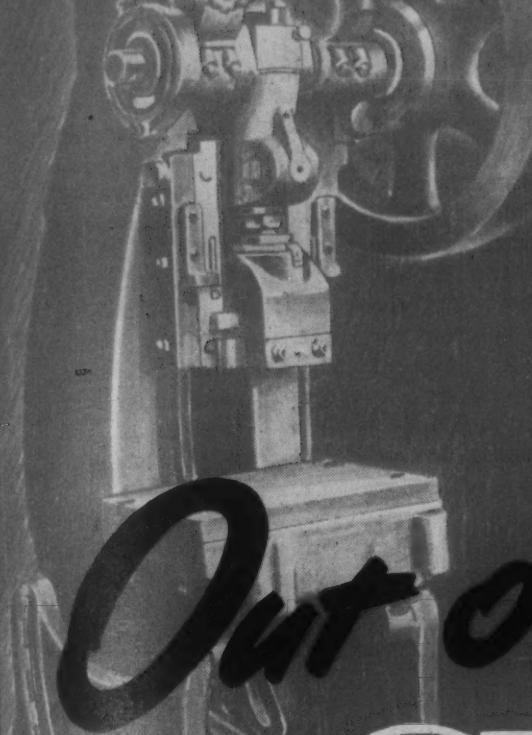
The problem of eliminating machining from the minor jigs is more complicated, but was solved by providing adjustment in

Out of the war comes

CROMOCO

AIR-HARDENING DIE STEEL

A "Substitute" that outperforms *Cromovan!*



SEND FOR BULLETIN SL-2002

One of the permanent benefits that will result from the war-time shortage of **vanadium** is the increasing knowledge and use of metals such as **cobalt.**

When, as a war measure, we were obliged to omit vanadium from Cromovan High-Production Die Steel, we substituted cobalt—with surprisingly good results. We named this new die steel CROMOCO.

The new grade **retains** the characteristics that made the older grade such a favorite: **Air Hardening; Ease of Machining; Non-Shrinking; Intense Hardness; High Compressive Strength;** and **Great Resistance to Abrasion.** And, we now find that CROMOCO actually outperforms its peace-time predecessor!

ARMY E NAVY

Firth-Sterling

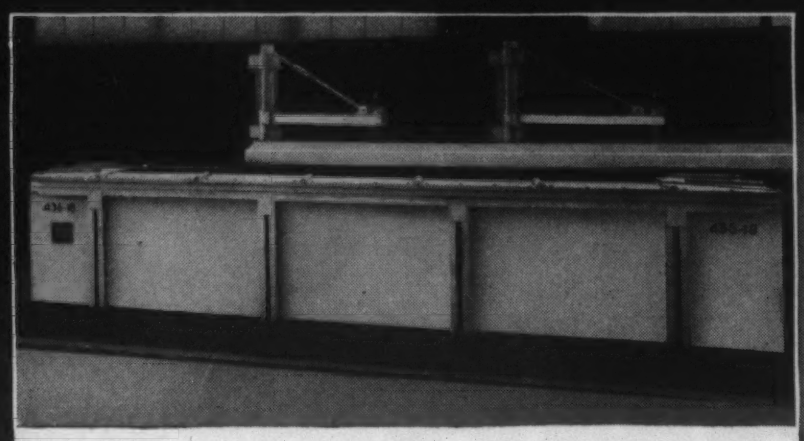
STEEL COMPANY

Also makers of "FIRTHALOY" Carbide Dies for Deep Drawing

OFFICES: McKEESPORT, PA.-NEW YORK-HARTFORD-PHILADELPHIA-CLEVELAND-DAYTON-DETROIT-CHICAGO-LOS ANGELES

Uniform Temperature + High Capacity with

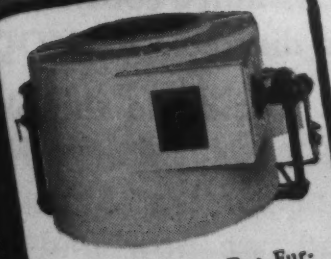
R-S Salt Bath Furnaces



R-S pioneered in the development of Salt Bath Furnaces for the heat treatment of aluminum alloy parts. Some of these installations have been in continuous operation for fifteen years or more.

The exceptional results obtained in temperature uniformity with the consequential uniform physical properties, have convinced such customers that these furnaces have no equal for heat treating aluminum.

High capacity with minimum floor space is also an important consideration.



Small R-S Salt Pot Furnaces are used for tempering, the solution heat treatment of aluminum parts, and for hardening steel.

If you need additional facilities for heat treating aluminum aircraft parts or stampings, we shall be glad to submit detailed information on the equipment required

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ANNEALING • PLATE AND ANGLE HEATING • FORGING
ROTARY HEARTH • METAL MELTING • CONVECTION
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R-S Furnaces of Distinction

BUY WAR BONDS

every fitting so that it could be set on a frame structure that was out of plane, and to weld without producing excessive distortion. The frames are made of low-carbon structural or tubular steel. A general purpose rod, like Fleetweld No. 7, is used, welding with short tacks.

The fittings are cut from cold-rolled steel; the entire structure is normalized, if necessary, and leveled on a large surface plate. Centerlines are scribed, the fittings are clamped roughly in place, then located accurately with a height gage. The welder tacks the fitting and the clamp is removed.

Cost comparisons based on a typical bulkhead assembly show a cost for the old construction of $696 as against $456 for the new, a saving of 34.5 per cent. Savings are more pronounced on these complicated jigs, but tool fabricating time on a four-engined airplane will run as high as 500,000 hrs., and a conservative average saving of 10 per cent will total nearly $150,000 for a contract.

—Harry V. Wenger, Jr., *Aeronautical Engineering Review*, Vol. 2, Mar. 1943, pp. 40-49.

Carburization and Decarburization

Condensed from "The Iron Age"

The methane-iron equilibrium has not received as much attention as the monoxide equilibrium. The work of Schenck is perhaps outstanding.

The effect of pressure on the methane-iron equilibrium is different from that of the carbon-monoxide-iron equilibrium. In the present case, one molecule or methane decomposes in two molecules of hydrogen, while in the former the two molecules of monoxide decompose to one molecule of carbon dioxide. This change in pressure affects the equilibrium constant.

While carburization can be accomplished by the reactions discussed, there exist distinct differences. The first difference is in the relative stabilities of the carburizing constituents. The second is that with the carbon dioxide, oxygen is introduced into the steel, but with methane this is not the case.

When a material is carburized with mixtures of carbon monoxide and carbon dioxide, a certain amount of oxygen is introduced simultaneously with the carbon, but the amount of oxygen absorbed usually is less than 0.01 per cent between 1740 and 1830 deg. F. Methane carburization introduces no oxygen, and perhaps even removes it, especially with hydrogen present.

In carburized steel the relation between oxygen and inclusions and the dependence of grain growth on inclusions often becomes apparent from the distinctly different grain pattern in the case, as compared to the unchanged core. Oxygen adsorption is marked in steels having some dissolved aluminum. Oxygen elevates the coarsening temperature of the steel, so that sharp change in grain size is manifest at the limit of oxygen penetration.

In dry-cyaniding ammonia is added to natural gas to introduce carbon to nitrogen. Advantage is that one can case harden at temperatures as low as 1150 deg. F. because the nitrogen decreases the critical points in steel.

Liquid carburizing depends upon the oxi-

THE SAME METHODS WILL WIN YOUR POST-WAR BATTLES

Since welding is taking such a big hand in winning the war, why shouldn't I watch it closely for ideas to win my battles for business after the war?

ALTER EGO: That's logical. Where you see welding, you see faster production and far better ships, planes, tanks and guns. The same basic methods can be used after the war to cut costs and build better autos, machines, appliances and buildings.

Can I get any ideas from the wartime gasoline tanks they're welding here?

ALTER EGO: Sure! In the first place, they're welded. And they're welded fast. Ever hear of welding 10 to 14-gauge sheet with 3/16" electrode? Usual practice requires 1/8" or 5/32" size. This shop developed fit-up jigs and positioning fixtures to allow the 3/16" size. *This bigger electrode saves them 33% in man-hours.*

Then, the big problem is not only to find ways to apply welding to my post-war products, but to find ways to beat competition on the cost of my welding.

ALTER EGO: You're right. You should use this double approach to post-war profits by keeping an eye on the big war-job welding is doing . . and by all means, ask for Lincoln cooperation on design and production.

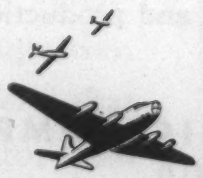
THE LINCOLN ELECTRIC COMPANY
CLEVELAND, OHIO

then I said to myself—

THERE'S ALWAYS SOMETHING NEW UNDER THE ARC

REASON FOR CONFIDENCE

THIS is a war of fire power. Regardless of the courage of our armed forces, regardless of the inspired leadership of our generals and their strategists—our armies must have superior fire power to win.



Pangborn Corporation, in company with the front line of American industry, recently won the Army-Navy "E" pennant for excellence in war production. This citation came because Pangborn ROTOBLAST Barrels, Tables and Special Cabinets—Pangborn AIR BLAST Rooms and Special Machines are removing scale and dirt from hundreds of thousands of castings, forgings, stampings, heat treated and other metal parts daily to help SPEED UP the fire power that is so badly needed NOW.

Pangborn men and management can, and WILL, do more. If you have a blast cleaning or dust control problem—"come to Pangborn." The recent citation—proudest in our 39 years of progress—plus the efficiency and performance built into every Pangborn machine—give irrefutable reason for your complete confidence.

PANGBORN

WORLD'S LARGEST MANUFACTURERS OF BLAST CLEANING AND DUST COLLECTING EQUIPMENT

PANGBORN CORPORATION • • HAGERSTOWN, MD.

dation of sodium cyanide to cyanate: $2\ NaCN + O_2 \rightleftarrows 2\ NaCNO$. The cyanate decomposes: $4\ NaCNO \rightleftarrows 2\ NaCN + Na_2CO_3 + CO + 2\ N$. The carbon monoxide dissolves in the bath and upon contact with iron is assumed to dissociate to carbon and carbon dioxide; the atomic nitrogen is absorbed as such.

Decarburization often is the undesirable consequence of improperly controlled heat treatment. It takes place in two ways: (1) A change in equilibrium between the carburizing gases and the iron may take place in such a way that the atmosphere will decarburize a given steel; and (2) oxidation occurs with an atmosphere which is oxidizing to both constituents but in different degrees.

Presence of carbon dioxide is often responsible for decarburization. Even if it is removed before the gas enters the furnace, the carbon monoxide may react in the hot zone to form carbon dioxide. To prevent this the carbon dioxide and moisture must be removed. Pure hydrogen with a dew point of —76 deg. F. is a decarburizer but a very slow one. Moist hydrogen, with about 3 per cent water (vol.) is a good decarburizer.

Most economical method to control decarburization is to use controlled atmospheres produced by combustion of city gas or natural gas. In such cases the carburizing nature of the gas is adjusted so as to be neutral to steel of a given composition.

—J. K. Stanley, *Iron Age*, Vol. 151, Jan. 28, 1943, pp. 36-39.

New Alloy Steel Welding Electrode

Condensed from "Steel"

The electric arc which is established between a coated welding electrode and the metal to be welded can be considered a minute continuous electric furnace where alloy steel can be manufactured in a manner similar to the process occurring in the electric steel furnaces.

In the "Agile" alloying process, nitrogen and oxygen from the air are excluded from the arc by a shield of inactive gases. Any nitrogen or oxygen that penetrates this shield reacts with denitrogenizing and deoxidizing particles contained in the electrode coating and is deposited in the slag.

The most important coating ingredient for alloy or tool-steel electrodes is carbon. Three modifications are used in the coatings: Carbohydrates, such as cellulose; wood charcoals; and cokes and graphites. The first two are used exclusively for furnishing and maintaining the desired atmosphere, while the latter supplies carbon to the alloy.

In addition to potassium or sodium silicates, which are used as a binder, the other slag-building constituents of the coating have the same purpose as the lining of the electric furnace and are added in proportions to be either acid, basic, or neutral in action. The molten slag has a specific-gravity and melting-point that permit it to rise to the top of the molten pool, thereby purifying the weld and protecting it against rapid cooling.

The alloying elements are also contained in the coating, usually as ferroalloys but sometimes as salts. Tool steels can be pre-

—and Hurry Back!"

We'll miss him, of course! But we'll have to manage somehow to get along without "Harcast" until the war is over.

As a patriotic duty, "Harcast" is stepping out of the picture for duration. He's giving up his place in production to his brother P&H Electrodes who are more vitally needed.

Meanwhile, volumes of these other P&H Alloy Electrodes, all types and sizes, will be reaching new highs to meet urgent demands of war industries — to be *where* they're needed, *when* they're needed to keep machines working for Victory.

Procedures on P&H Alloy Electrodes are available on request.

P&H Alloy ELECTRODES

P&H Square Frame Welders are described in Bulletin W-26. Write for it.

ARMY E NAVY

A new star has been added to P&H's award for excellence in war production.

General Offices: 4550 West National Avenue
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IN HEAT TREATING METALS

RIGHT BEFORE YOUR EYES!

In controlling quality of treated metals, uniform atmosphere composition must be maintained. Ranarex* makes this easy. Just glance at the indicator and note the specific gravity of the atmosphere gas. You can depend upon Ranarex. It's always exact, easy to use, and adaptable to stationary or portable use.

PURGING SAFE WITH RANAREX

Measure the specific gravity of outlet gases and continue purge until the specific gravity of the atmosphere gas is reached. Then you know gas contains no air. Purge is complete! Gas and time are saved.

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PERMUTIT'S

RANAREX

pared by using ready-made intermetallic compounds as part of the electrode coating or by forming the desired intermetallic compounds through reactions taking place in the electric arc. In the latter case the elements forming the compounds are furnished by the coating.

The intermetallic compounds in the coating pass through the arc at a rate of 250 to 300 droplets per second. Because of their very high melting points, they do not melt completely. The molten steel droplets passing through the arc absorb these hard particles, and when they contact the molten pool, solidify so fast that an even distribution of the intermetallic compound is assured.

Thorough examination of deposited beads has shown that the hardness of these weld-metals is very uniform. Virtually no difference in hardness or structure can be detected throughout the length of a bead produced by an 18-in electrode.

This process can be used for putting tips on pneumatic chisels, to build up edges on machine cutting-tools, such as punches, shear-blades, and dies, and for reclaiming concrete mixers, chopping blades, and other tools subject to impact.

—J. A. Neumann, *Steel*, Vol. 112, Jan. 11, 1943, pp. 74-76, 78, 80.

Electroplating on Non-Conductors

Condensed from "Engineer"

Difficulties encountered in electroplating on a graphite film have been investigated by E. G. Acheson, Ltd. A new technique for electroplating on non-conducting materials depends on two stages: First, there is the production of graphite film of maximum electrical conductivity, and secondly, the treatment of the film to render it resistant to water.

Maximum conductivity of graphite film depends to a large extent on the basal orientation of the flat graphite particles which compose the film. Thus, if the colloidal dispersion is applied to a relatively rough or porous surface, the particles will not orientate effectively. This has been surmounted by applying a material to the rough surface which produces a smooth exterior. It may be achieved by the use of a mixture of potassium bichromate and gelatine.

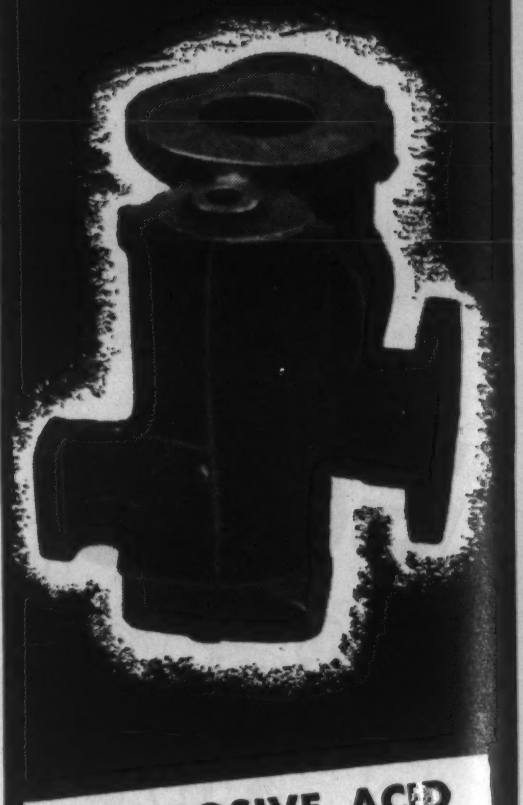
By suitable control over the size of the graphite particles different ranges of conductivity in graphite coating can be obtained. If the latter is quite dry it may be burnished further to improve the conductivity, and a value of 20 to 30 ohms per sq. in. may be obtained.

The moisture resistance of the coating can be improved by the application of a very thin film of wax. The wax may be non-conducting, but the use of a sufficiently thin film on top of the graphite will not affect the conductivity.

By this method copper, nickel and other metals have been deposited on wood, plastics and cardboard. Precautions necessary are proper waterproofing of back and edges which are not covered by the graphite.

—*Engineer*, Vol. 175, Feb. 19, 1943, p. 160.

Correct Analyses Assured in Atlas



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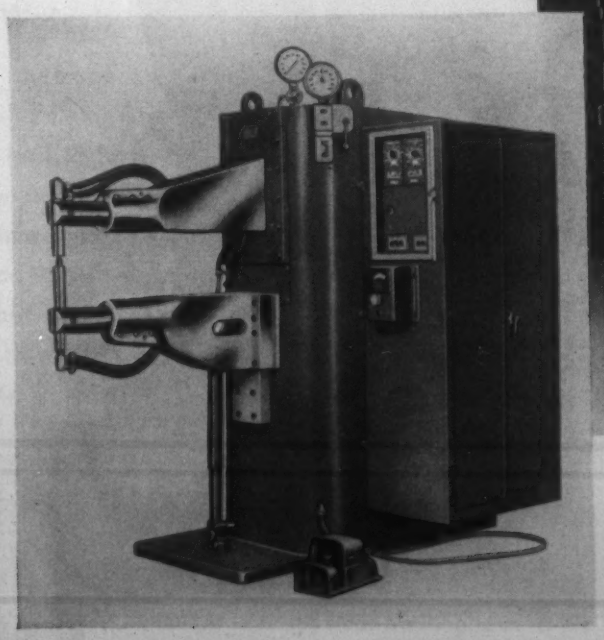
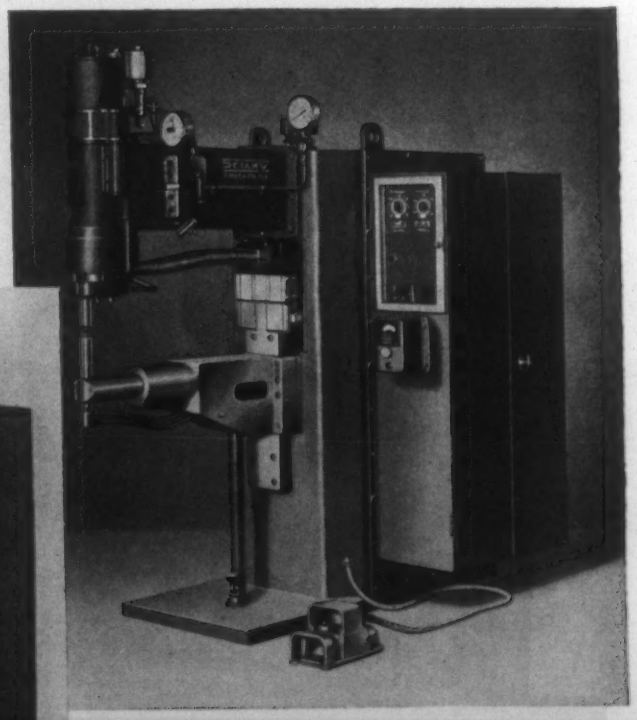


SCIAKY TYPE PMCR. 2S16 ELECTRIC RESISTANCE ROCKER ARM WELDER, welding 70 spots per minute, on two sheets of aluminum alloy of .040" each. Welding capacity from two thicknesses of .016" in aluminum alloys up to and including .080".



TYPE PMCO. 2S16 SCIAKY ELECTRIC RESISTANCE WELDER. Eighty spot welds per minute on two sheets of light alloy of .040" each. Welding capacity — from two thicknesses of .016" each in light alloys up to .091".

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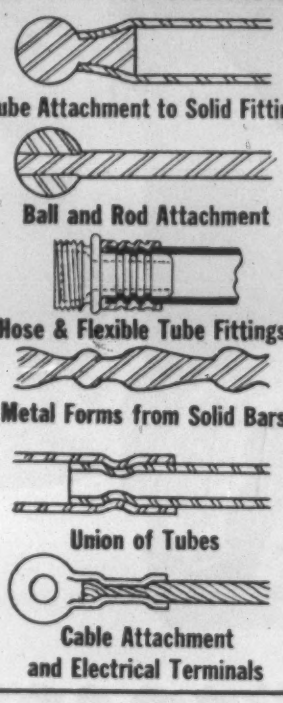

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In one operation, this machine connects tubing or cables to solid fittings, or forms metal sections from solid bars without cutting. A feature of its design is the use of hydraulically-operated wedges to compress the dies so that swaging force is applied at right angles to the work . . . not obliquely as with tapered dies. In reducing outside diameter of tubing, therefore, tendency toward elongation is lessened and thickness of tubing wall is increased. Fittings having large ends can be put into machine without removing dies. This machine simplifies handling of many other operations which previously required more complex, time-consuming methods.

Further information on request.

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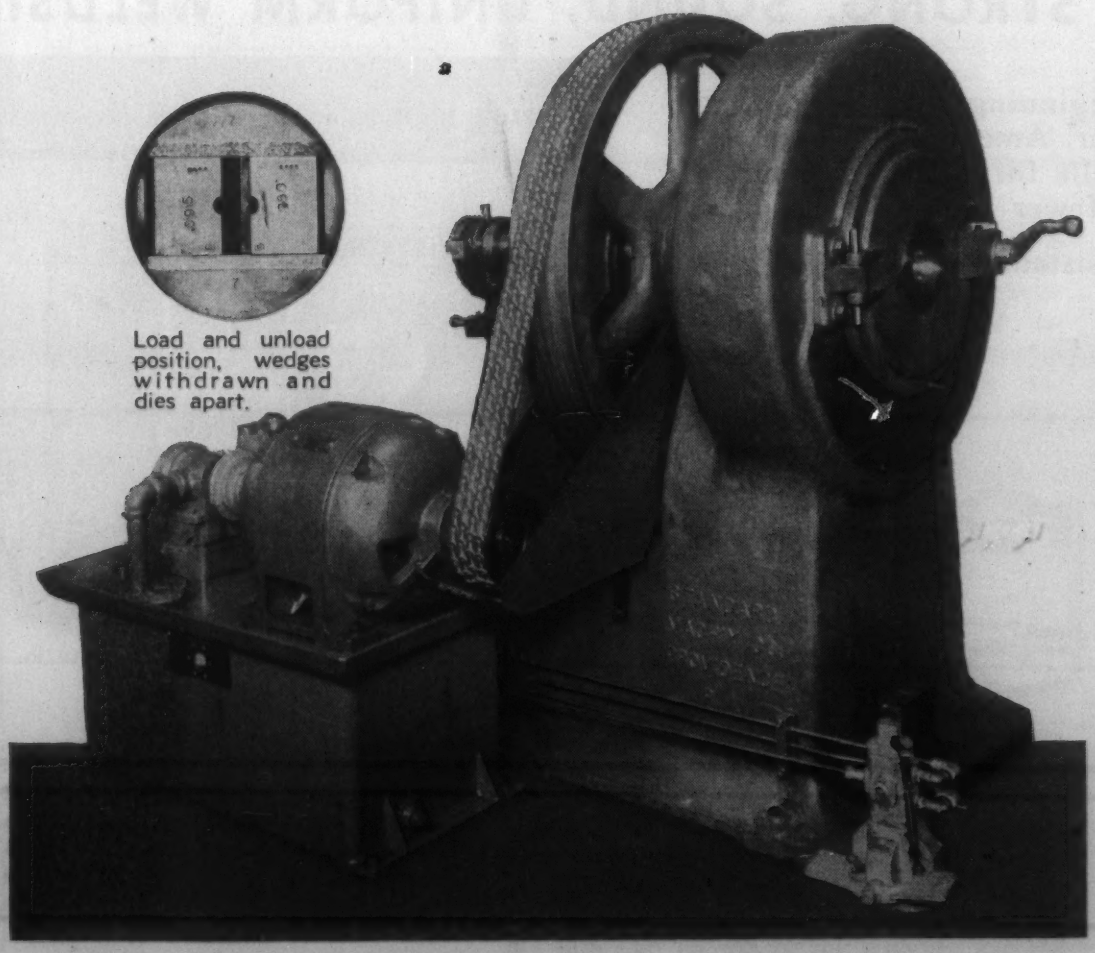

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Wartime Soldering

Condensed from "Electrical Review"

Use of cored solder necessitates pro cedure that differs from methods which are appropriate to stick solder with a separate flux. The cored variety is in the form of a wire, 10-22 S. W. G. in diameter, in which one or more cores of flux are incorporated. The multicore type, having 3 cores of flux, is preferred.

For electrical purposes, the flux should be non-corrosive and the fumes dissipated from the flux during the soldering operation should have no harmful effect on the part being soldered or other parts in the equipment. Therefore, it is specified that either resin be the flux used or the flux residue must be pure resin. As resin is one of the least active of fluxes, much research has been done on the production of activated resin fluxes. During soldering the activating agent removes oxides from the surface, prevents their formation during the operation and then dissipates, leaving pure resin.

Cored Soldering Faster

While cored solder costs considerably more than stick solder, soldering with the former is faster and labor costs are lower. In addition, use of a fine wire instead of a large stick enables the exact quantity required for each joint to be predetermined and controlled. If a simple technique is evolved, unskilled women can do the soldering with the cored variety.

If the soldering-iron can be dispensed with and the cored solder wire applied directly to the heated part, there will be no danger of molten solder being applied to a comparatively low-temperature part and a sound joint will more likely result. The solder wire should be applied to the work to be soldered, not carried to it on the tip of the iron. If the latter is done, the activity of the flux will be wasted. The solder must be applied to the work either at the same time as the heat is applied or after the temperature of the part has been raised to the liquidus temperature of the solder.

In attaching wires to tags, the solder wire should be applied across the shank of the tag and the iron placed on top. When a piece of wire equal to the width of the tag has been melted, the iron is withdrawn.

The highest tin-content soldering alloy now permitted without a special license in England contains 45 per cent Sn and 55 per cent Pb. Its liquidus is 227 deg. C. (437 deg. F.), and solidus, 183 deg. C. (361 deg. F.). If this alloy is substituted for the 60-40 alloy, the bit temperature of the soldering-iron, if correct, for the latter, must be increased by at least 30 deg. C. (55 deg. F.). Many of the electric irons available in England, especially those having pencil bits, are incapable of handling the 45-55 alloy without modification. When such irons are used, the solder often does not become liquid but remains in a pasty state.

Bit Temperatures

The soldering-iron should have a bit temperature 40 deg. C. (70 deg. F.) higher

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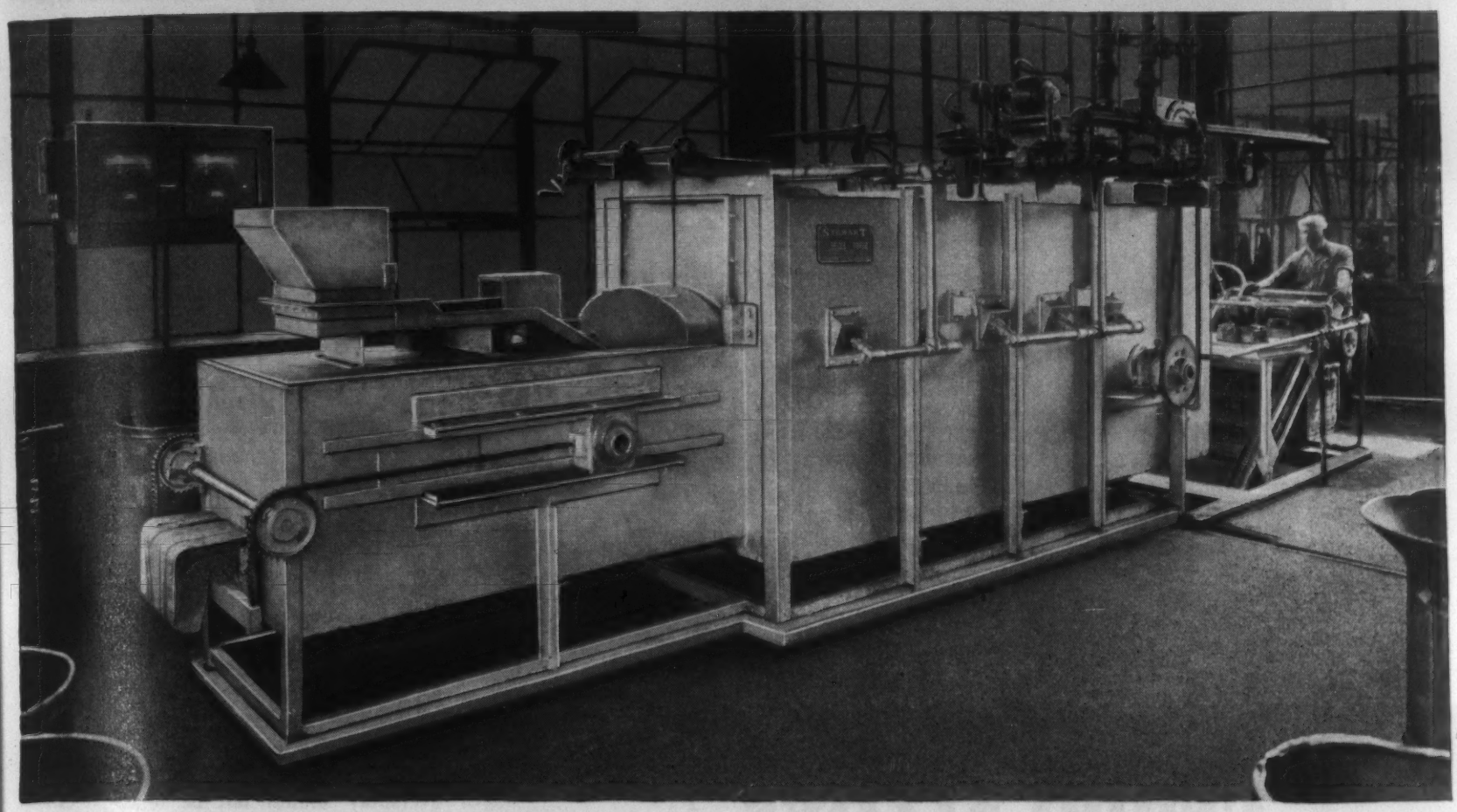


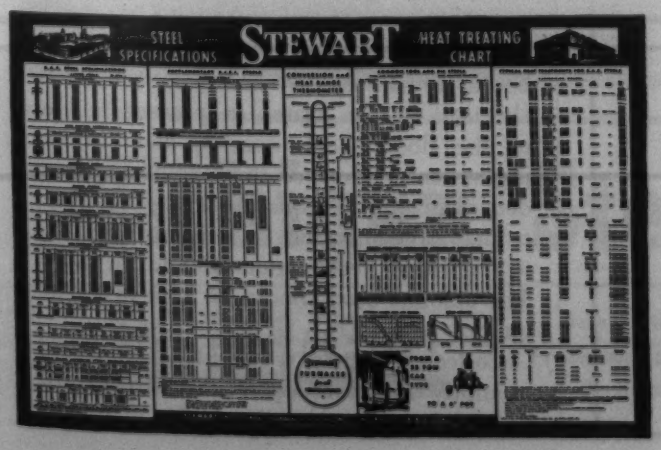
"Since we have installed the Stewart Conveyor Hardening Furnace (illustrated above), we are handling 6000 lbs. of rings in a 10-hour shift with one man, and we find that we have cut our hardening costs approximately in half," writes Stuart E. Judd, Secretary and Treasurer, Mattatuck Mfg. Co., Waterbury, Conn.

"In buying equipment to do our hardening automatically, we started with two basic requirements: namely, flexibility, and low operating cost," writes Mr. Judd. "We had to have flexibility because, in addition to our regular lines, we do special order work for others, and through a year's time will make many different sizes and shapes of articles. A furnace with an eighteen-inch-wide conveyor belt and a heat chamber eight feet long would give us 500 lbs. of work per hour, which would take care of our manufacturing capacity with a margin to spare.

"After a year of operation, the Stewart Conveyor Hardening Furnace has entirely lived up to our expectations and specifications, and we look back upon the 'old days' with wonderment as to why we didn't get wise to the possibilities of automatic equipment years ago."

This installation is typical of the industrial furnaces Stewart engineers are building every day to meet the specified requirements of manufacturers all over the continent.

Stewart builds, in addition, a full line of standard-type furnaces.



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than the liquidus of the solder alloy being used. The liquidus of the 40-60 alloy is 238 deg. C. (460 deg. F.); 30-70 alloy, 257 deg. C. (494 deg. F.); and of 18.5-81.5 alloy, 277 deg. C. (530 deg. F.). The type of part being soldered will have an effect on bit temperature after several parts have been soldered. Irons having an excessive bit temperature should not be used, as too much time will be required for the solder to solidify and the activity of the flux can be destroyed.

For many purposes where single parts are being soldered, the use of bench-type irons is advantageous, the part being taken to the iron instead of vice versa. The soldering of some small pieces can be speeded up by filing a recess in the bit of the iron so that the heat is applied to a greater surface instead of one point.

—Richard Arbib, *Electrical Review*, Vol. 131, Dec. 18, 1942, pp. 777-779.

Recovery of Coating Overspray

Condensed from "Industrial Finishing"

During the few years immediately preceding the war, recovery of overspray was rapidly becoming established as a regular part of industrial finishing operations, leading to attractive reductions in finishing costs. In the present war program, overspray recovery is particularly important because it is a means of conserving the critical ingredients used in Government specification coatings.

Finishing department personnel must be educated to regard overspray as a valuable material, not as a worthless "sludge." Only one type of paint should be sprayed in a water-wash recovery unit. Two cases of overspray should not be mixed. An exception is the case where two or more colors of compatible types of finishes mix to give a color which can be used as an under-coat, sealer-coat, or as a finish for unimportant or concealed parts.

Overspray must be kept clean. Contaminants such as metal objects (nuts, bolts, etc.) are likely to damage reclaiming machinery. Paper, cloth, etc. is disintegrated and dispersed in the reclaiming process and cannot be filtered out. Dried overspray such as scrapings and sweepings should not be added to the water-wet overspray.

In rare instances, where a relatively non-oxidizable finish is used, such material can be reclaimed, but should be collected frequently and placed under water. Collected overspray should be kept under water and removed from the tanks twice per shift in order to avoid oxidation.

In the operation of a water-wash spray booth it is usually necessary to add a chemical to the water to prevent fouling of the flood sheet, nozzles, and circulating system. Most of these compounds are detrimental to the quality of the reclaimed paint. A compound formulated especially to facilitate reclamation should be used. The amount used should be kept to a minimum.

Collected overspray should be returned promptly in clean, open-head drums. At least 4 in. of water should be placed on

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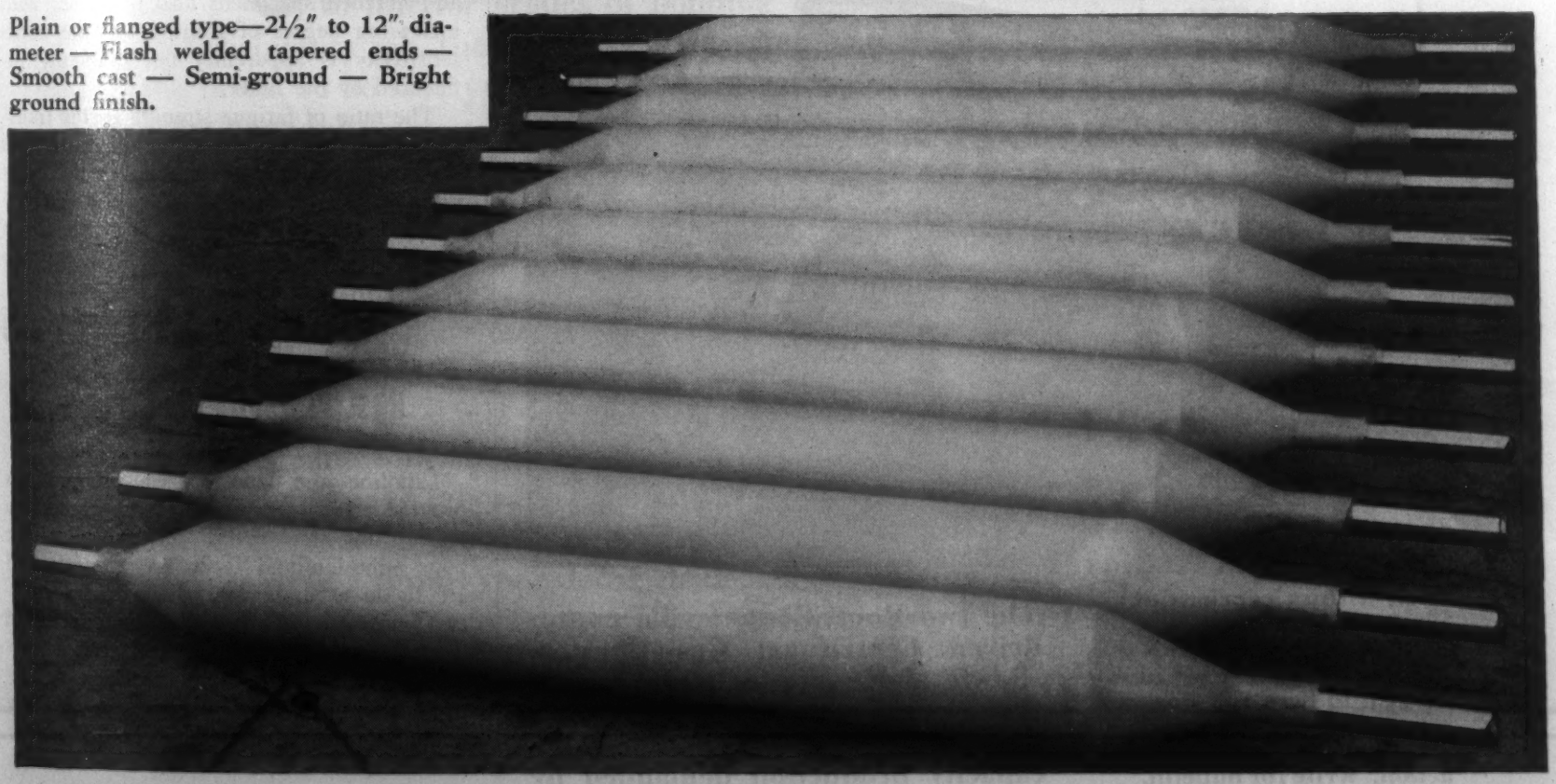

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The two Roots-Connersville motor-driven Centrifugal Gas Boosters shown above are delivering blast furnace gas in a large automobile plant, thus helping to maintain the capacity production demanded by their war-work schedule.

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Centrifugal GAS EXHAUSTERS and BOOSTERS

top of the overspray in the drums. Dried paint skins or any type of foreign matter in the drum may contaminate the material so that it cannot be reclaimed.

The overspray should not be stored for long periods before processing, particularly in a place where the temperature is higher than normal.

—John J. Zolad, *Industrial Finishing*, Vol. 19, No. 4, 1943, pp. 69-72.

Forging and Fatigue Strength

Condensed from "Archiv Eisenhüttenwesen"

The influence of the degree of forging on the bending fatigue strength of alloy structural steel was studied, longitudinally and transversely to the forging fibre. A steel of 0.32 C, 0.43 Si, 0.26 Mn, 0.020 P, 0.018 S, 0.22 Cr and 0.99 per cent Ni was investigated after forging in 4 stages, as given in the table.

Stage	*Diam., mm.*	*Degree of forging, taken from original blank dimensions*
A	540	3.1 times
B	435	5.6 "
C	[illegible]	13.4 "
D	[illegible]	26.2 "

The results show that the ratio of fatigue strength to tensile strength of smooth and notched specimens decreases in the longitudinal fibre with increasing degree of forging, and notch sensitivity also increases. In the transverse fibre, the ratio of fatigue to tensile strength of smooth and notched specimens also decreases with increasing degree of forging but the notch sensitivity is apparently not markedly influenced by the latter.

The ratio of fatigue strength in the transverse fibre to that in the longitudinal fibre of smooth and notched specimens decreases with increasing degree of forging whereby the decrease in bending strength from longitudinal to transverse fibre is greater in smooth than in notched specimens.

—H. Krainer, *Arch. Eisenhüttenw.*, Vol. 15, June 1942, pp. 543-546

Rust Protection in Storage

Condensed from "Metal Treatment"

Lanoline and lanoline-base preparations provide effective temporary rust protection to iron and steel parts. Mineral oils have poor adhesion and low film strength and are liable to drain away from sharp corners; moreover, water drops or condensed moisture films will cause steel to rust below mineral oil or jelly coatings. Machine shop lubricants and cutting oils are liable to contamination and should not be relied upon for even moderate storage periods.

Lanoline may be applied by dipping, brushing, or with a cloth pad, and is generally used with mineral oil or jelly carriers containing 20-30 per cent of lanoline or with volatile solvents containing 20-35 per cent of lanoline. Lanoline should not be used on copper or copper alloys since it causes green corrosion on these metals.

—E. Armstrong, *Metal Treatment*, Vol. 9, Summer 1942, pp. 3-10, 24.

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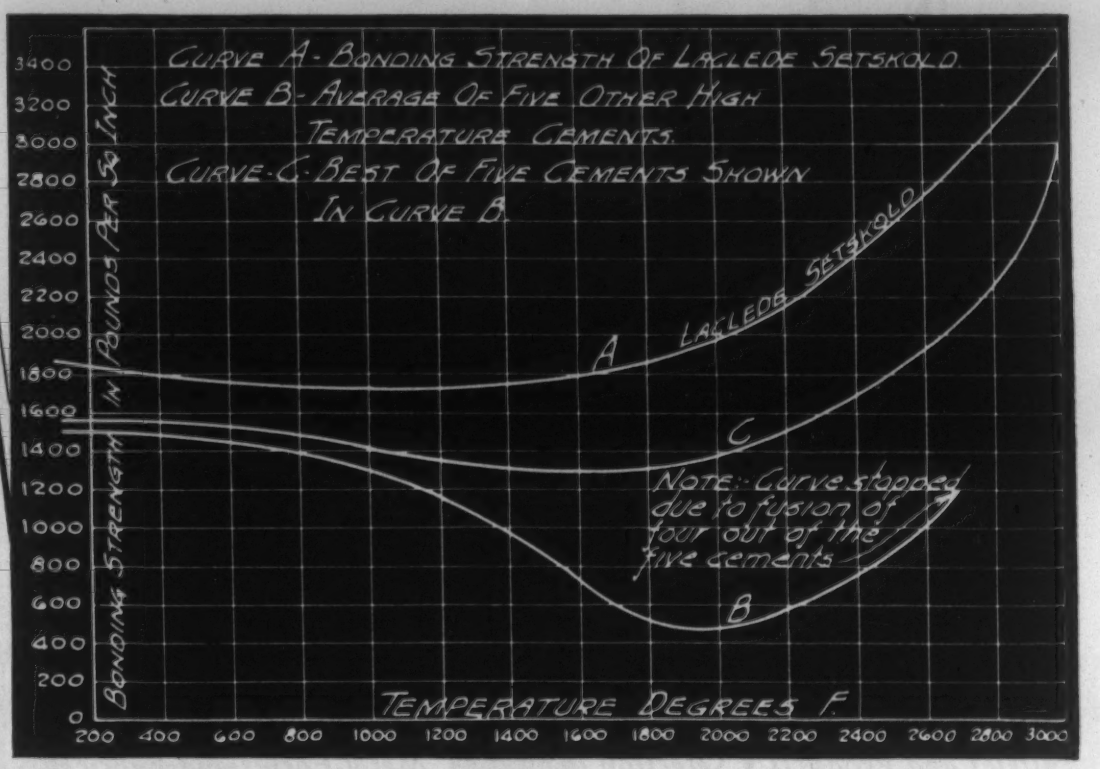

Facts illustrated by graph clearly and accurately reveal result of tests on five brands of refractory cements as compared with Setskold.

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When you have a problem involving refractories, call in a Laclede-Christy engineer. Because Laclede-Christy offers a *complete* line of refractories, he will give you an unbiased recommendation — the *right* recommendation for your job. Complete blueprints and estimates will be furnished without cost or obligation.

Write for complete details on Setskold and Setskold C-7.

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Stress Cracking of Brass

Condensed from "The Iron Age"

Under ordinary atmospheric conditions a brass containing less than 80 per cent Cu is susceptible to season cracking, *i.e.*, fracturing in the presence of small internal stresses. The homogeneous, copper rich, alpha brasses, the homogeneous beta brasses, containing about 50 per cent Cu, and the heterogeneous brasses with 55 to 62 per cent Cu may develop season cracking under favorable conditions. The cracks have an intercrystalline nature in alpha and beta brasses.

From lightly corroded fractures caused by season cracking a slight amount of ammonia could be extracted. This is due to ammonia being present in the atmosphere which is responsible for season cracking.

Molten tin and lead, as in the case of soldering, will cause brass to fail if sufficiently high stresses are present in the brass.

The Mercury Test

However, more important is the cracking due to mercury. While mercury cracking has no established relationship to corrosion cracking, its mechanism is closely related to that of true corrosion cracking. Therefore, the mercury test is generally accepted as a suitable measure of the susceptibility of brass to cracking in atmosphere.

The standard mercury solution in this country is 10 per cent mercurous nitrate and 10 per cent nitric acid. But it has also been noticed that the 10 per cent solution is not suitable for the visual detection of small, slowly forming cracks, which may be covered up by excessive mercury precipitation.

Samples exposed to liquid mercury in ordinary atmosphere possessed a lower cracking tendency than identical samples subjected to mercurous nitrate solution. However, samples tested in a nearly perfect vacuum by exposure to liquid mercury cracked much faster than at normal atmosphere.

Effect of quantitatively known stress produced by applied external loads has only recently received consideration. Cartridge brass (70% Cu, 30% Zn) strip in annealed and rolled conditions will crack within 14 days in the mercury test if subjected to a tensile stress above 13,500 lbs. per sq. in. but below 18,000 lbs. per sq. in. Annealed cartridge brass rods were found to fail in an ammonia test only after 20 days if applied tension was but 5,000 to 10,000 lbs. per sq. in. Similar observations were made on Muntz metal.

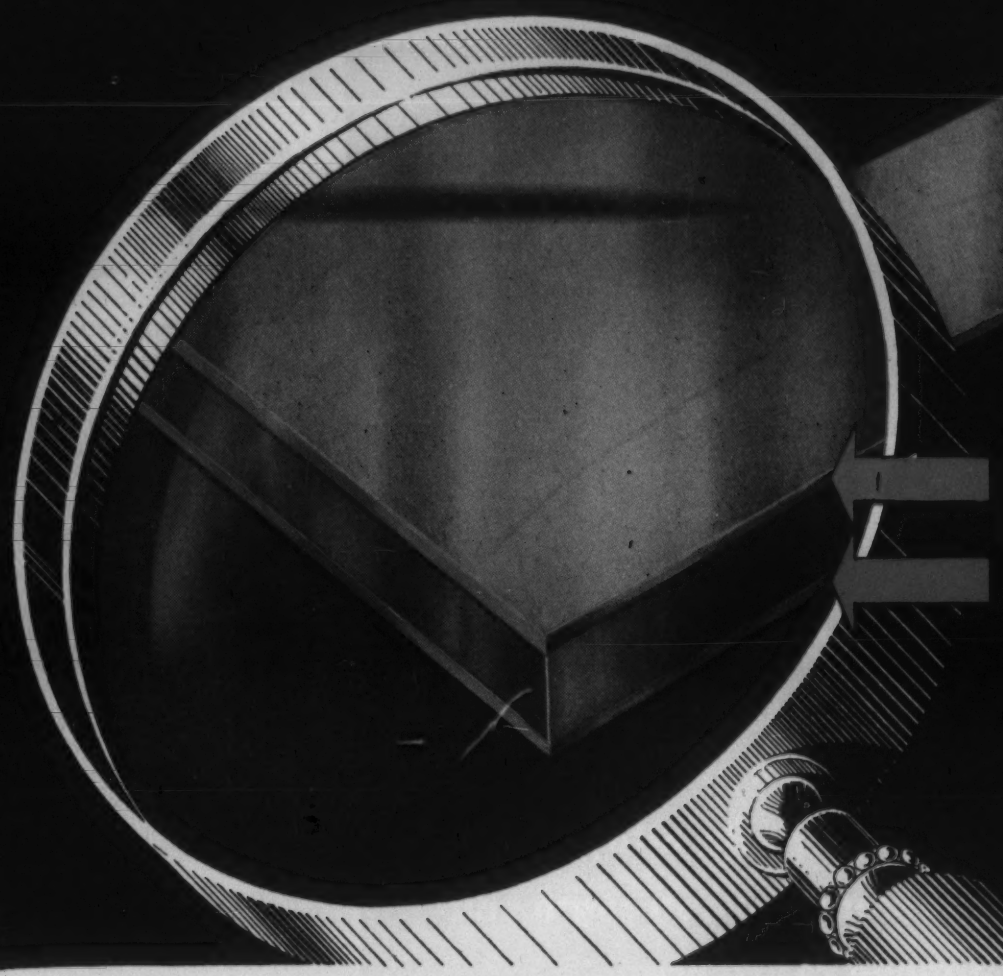
Effect of cold work proper can be explained by the accepted conception that cold work causes a progressive fragmentation of the crystals.

Cracking in Service

Corrosion cracking in service is attributed to the presence of residual stress in cold-worked tubing, drawn rod, etc. Tensile stresses which exceed the magnitude required for both corrosion and mercury cracking have frequently been found to be present in the surface layers of such products, while they were exposed to attack of atmosphere, ammonia, or mercury. Magnitude of these stresses can be determined only in an approximate manner by mechanical methods. Investigations carried out regarding the correlation between residual stress and resulting mercury cracking, which confirm the general view that the presence of tensile stresses higher than approximately 15,000 lbs. per sq. in. at the exposed surface is a prerequisite of mercury cracking.

There are numerous other factors which influence stress cracking, particularly factors resulting from variations in the processing of brass. The cracking tendency in both the atmosphere and mercury increases with the grain size of the annealed metal. However, single crystals, which do not contain any grain boundaries, are not subject to mercury cracking.

This grain size effect is retained in cold stretched wire, but is progressively reduced by cold drawing. Stress relief annealing again increased the difference between



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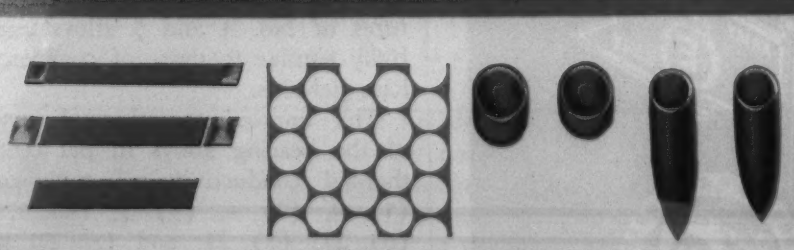
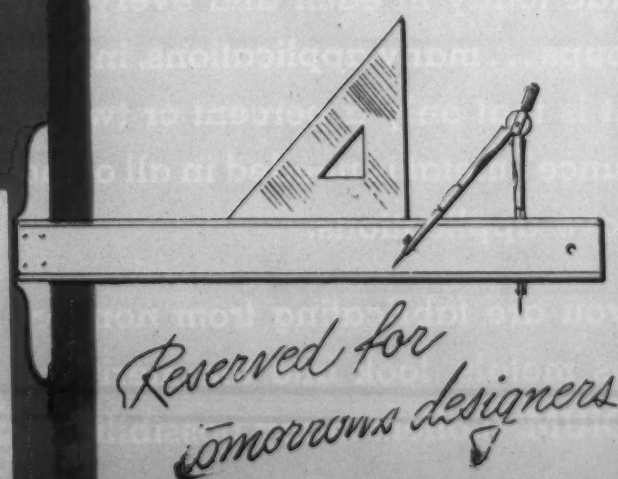


. . . from the SuVeneer gilding metal clad strip, to cups, to finished bullet jackets.

"SuVeneer" in Peace



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cracking tendencies of fine-grained and coarse-grained cold-drawn wires.

Commercial cold-worked brass may or may not be highly susceptible to stress cracking, depending upon the sign and magnitude of the residual stresses developed. Residual stresses are materially changed by subsequent cold working.

Relief of stresses in a low temperature annealing operation does not take place suddenly and entirely at the points when hardnesses and yield strengths reach a maximum. On the contrary, these stresses and resulting tendencies to crack decrease gradually as the temperature changes from above room temperature to those points at which complete recrystallization is effected.

To date, no lucid explanation can be advanced for stress cracking. However, difference in potential between crystal grains and grain boundaries has a deciding effect in corrosion cracking. The presence of grain boundaries is necessary. Single crystals are not liable to stress cracking.

Tendency to crack, or rate of cracking, decreases with decreasing grain size. Stress cracking of brass is intercrystalline in nature. Some chemical reaction must occur between the brass and another substance. This reaction might be of the corrosive type.

—H. P. Croft & G. Sachs, *Iron Age*, Vol. 151, Mar. 11, 1943, pp. 47-50; Mar. 18, 1943, pp. 62-67.

Corrosion of Bearing Alloys

Condensed from "S.A.E. Journal"

The Underwood oxidation apparatus was used for the investigation of the corrosion of bearing alloys by lubricating oils. Bearing shells were accurately weighed before test and after each 10-hr. test interval. Analyses of lubricating oils were made at 10-hr. intervals. Most tests were run for 40 hr. at 325 deg. F., but several 20-hr. tests were also made at 350 and 375 deg. F.

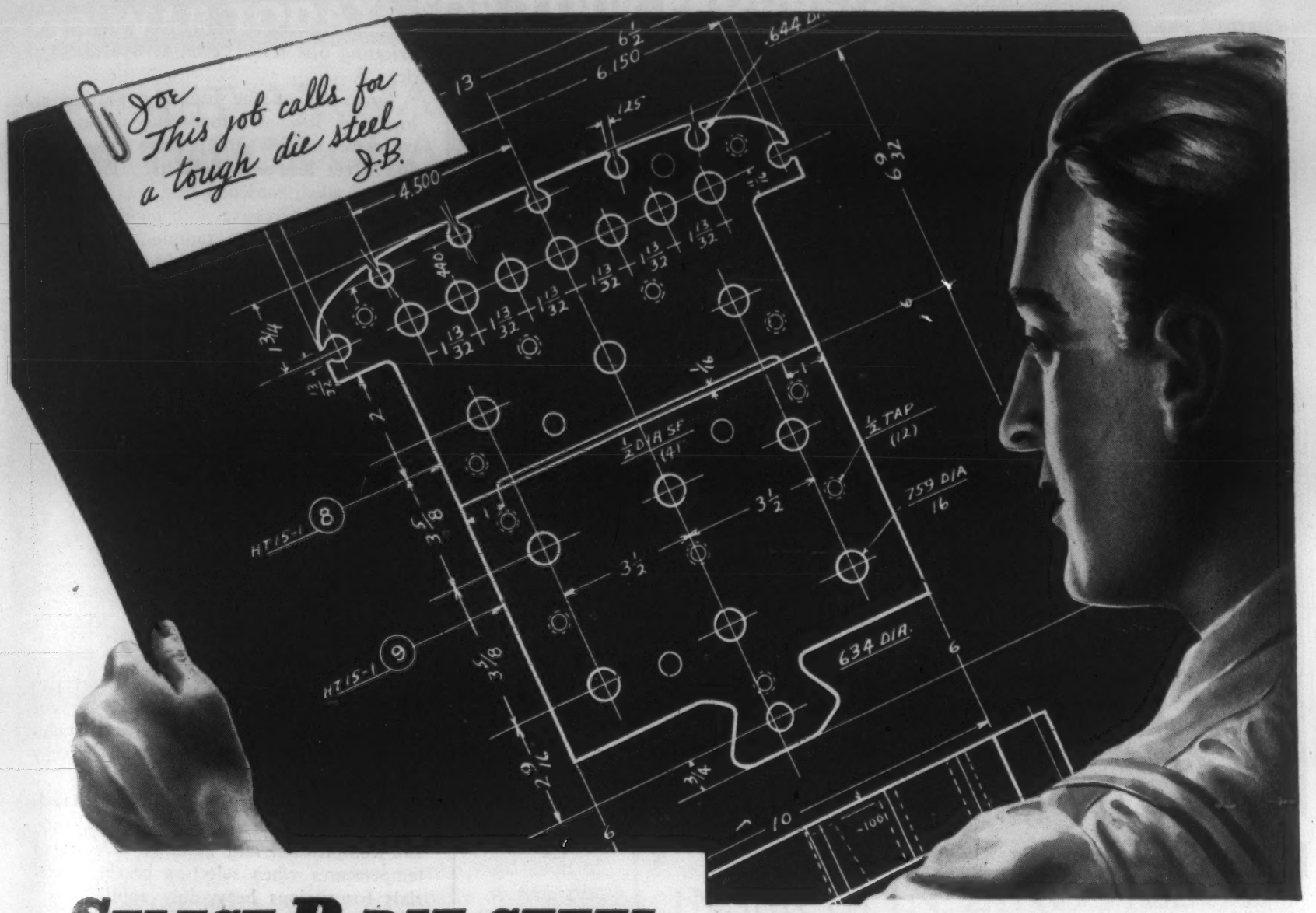
The bearing alloys investigated were (1) tin-base Babbitt, (2) lead-base Babbitt, (3) alkali-hardened lead Babbitt, (4) arsenic lead-base Babbitt, (5) silver lead-base Babbitt, (6) cadmium-silver alloy, (7) cadmium-nickel alloy, and (8) copper-lead alloy.

Compositions of the alloys and of the oils are tabulated and the results of the tests are presented on graphs. The structures of No. 4 and 5 alloys were essentially similar to those of commercial lead-base Babbitts.

The approximate thermal conductivity of the bearing alloys in per cent of the thermal conductivity of pure copper is (1) 9, (2) 6, (3) 5, (4) 5, (5) 5, (6) 21, (7) 21, and (8) 30 per cent. The straight mineral and the additive-type lubricating oils used possessed various characteristics. S.A.E. 30 grades were used. Some tests were made with re-refined oils.

Corrosion Data

Corrosion of the copper-lead bearings was mainly uniform, while that of the white bearing alloys was mostly localized. The accelerated corrosion test results indicate that the corrosion of the tin-base



SELECT B DIE STEEL
...for toughness

"My problem is simply this: I have to choose a die steel that is tough and yet withstands considerable abrasion." So said a perplexed die shop superintendent recently to our metallurgical service man. "And don't forget," he added, "it has to machine easily, must be non-deforming and can't be ground after hardening — so the die must be free from scale or decarburization after heat treatment."

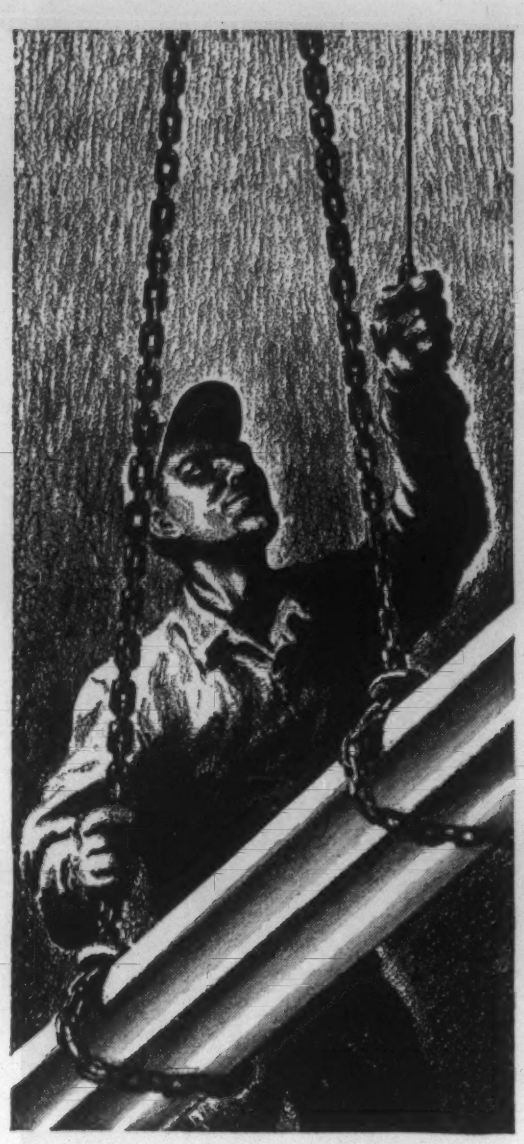
"Well, here is the answer," said the Latrobe Metallurgical Service Man. "It's *Select B* . . . a tough die steel that won't deform and will withstand abrasion. As far as heat treating, that is easy: Pack the die in sifted grey cast iron chips, dry charcoal or spent carburizing compound. Cast iron chips will prove preferable, since they won't build up carbon and cause brittleness of cutting edges.

"Since the dies are of a rather intricate nature, preheat at about 1400°F. As soon as they have become heated to this temperature bring furnace up to 1750–1775°F. Hold for just sufficient time for the container to become thoroughly heated, then remove the part and air cool in still air.

"When you can just about pick the dies up with your bare hand draw them at 900°F. The thickness being about 2½", hold for about four hours at this temperature. This will give a hardness of about Rockwell C-58 with the necessary toughness."

The result: This Company greatly simplified their die machinery problems, the production was increased and a substantial saving in their die steel costs was secured. It's a simple illustration of the timely help you can get to meet today's vital production problems with Latrobe Metallurgical Service. It's a technical help you can feel free to use. A special bulletin on "Select B" is available.

LATROBE
ELECTRIC STEEL COMPANY
MAIN OFFICES *and* PLANT - - - LATROBE · PA·



HOW TO SAVE CRITICAL ALLOYS

BY THE TON!

How do you intend to fabricate that steel you've ordered? Your answer may conserve tons of critical alloys... save you trouble in the bargain. This recent Frasse case history will testify:

The contractor had just ordered 2½ tons of high sulphur, free-machining stainless bars. Frasse, following its usual practice, made a routine check on the end use. Working on subcontract, purchasor was unable to give details—added that machineability was his only concern.

Frasse insisted. Purchasor contacted his prime contractor... learned that the steel was used for aircraft cable terminals. Familiar with this application, Frasse knew the parts would be swedged —warned that high sulphur stainless would crack in the operation.

Instead, Frasse recommended selenium free-machining, rather than a high sulphur stainless. The suggestion was accepted—with this subsequent comment by the customer: "Frasse foresight and knowledge saved us from machining critical alloys which would have been a total loss."

Here is conservation by the ton. Why not keep your steel source fully informed on your fabricating operations? Combined with his steel "know how", your data will eliminate expensive rejects... conserve critical material ... help America do the job. *Peter A. Frasse and Co., Inc., Grand Street at Sixth Avenue, New York, N.Y. (Walker 5-2200) • 3911 Wissahickon Avenue, Philadelphia, Pa. (Radcliff 7100 - Park 5541) • 50 Exchange Street, Buffalo, N. Y. (Washington 2000) • Jersey City, New Jersey • Hartford, Connecticut • Rochester, N.Y. • Syracuse, N. Y.*

Frasse

Mechanical and Aircraft STEELS

SEAMLESS MECHANICAL AND AIRCRAFT TUBING • COLD FINISHED BARS ALLOY STEELS • AIRCRAFT STEELS • STAINLESS STEELS AND TUBING DRILL ROD • COLD ROLLED STRIP AND SHEETS • WELDED STEEL TUBING

bearing alloy was negligible with all lubricating oils tested, even at 350 and 375 deg. F.

Corrosion of the lead-base bearing alloys was low and moderate. The least corrosive in this group were the arsenic and silver lead-base Babbitts. The corrosion of alkali-hardened lead was low with one oil and excessive with another oil.

Corrosion of the cadmium-base alloys was high. Excessive corrosion of cadmium-nickel occurred within the first 10 hrs. at 325 deg. F., and in the case of cadmium-silver within 20 hrs. with the oil that caused high corrosion of the alkali-hardened lead. Copper-lead bearings also corroded excessively.

An increase in the test temperatures accelerated the oxidation and rate of acid formation of the lubricating oil and the corrosion of the tested bearings. Tests with compounded and re-refined oils indicate that careful selection of additives should be made to reduce the corrosiveness of the uncompounded oil. Some additives can increase corrosiveness.

The bearing alloys which have a tendency to corrode at elevated temperatures should be lubricated with low-corrosive oils. Adequate cooling of the oil is of paramount importance, because it will impede oxidation of the oil, and thereby diminish bearing corrosion.

Corrosion information should be included with fatigue strength, heat conductivity, and compression and hardness at elevated temperatures when selecting bearing materials for various heavy-duty applications.

—L. M. Tichvinsky, *S.A.E. Journal*, Vol. 51, March 1943, Trans. pages 69-77.

Palladium and Palladium Plate

Condensed from "Metal Finishing"

Palladium, since becoming available to industry in 1919, has grown steadily in importance. Palladium is one of the metals not on the critical list at present and it is therefore being used as a substitute for restricted white metals such as platinum, rhodium, and nickel. It is about half as abundant as platinum and is the cheapest and next to the lightest of the metals of the platinum group.

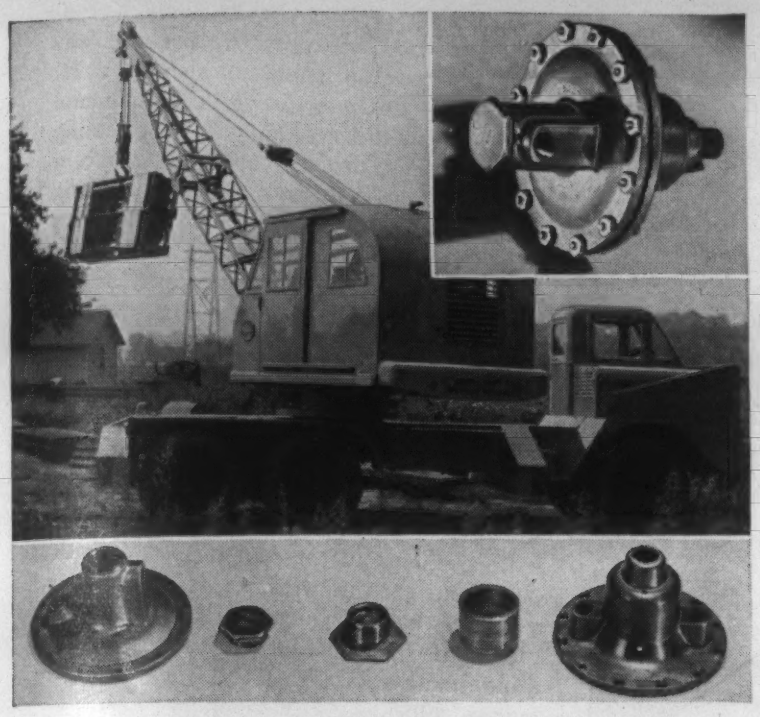
The price of palladium is $25 per ounce. The estimated world production of palladium in 1938 was 162,000 ounces. Part of the production is obtained as by-products in the purification of nickel, copper, and gold. Consumption is less than this so that stocks are increasing. Stocks on hand in the U. S. in 1940 amounted to 93,244 ounces.

Palladium is a silver-white metal similar to platinum. Its specific gravity is 12.16. For the same thickness of plate, palladium costs about one-third as much as platinum.

Palladium is very ductile and malleable. The annealed metal has a Brinell hardness of 49. Electrodeposited palladium is as hard as nickel. Its reflectivity is given as 74.8 per cent.

Palladium does not tarnish in air and is immune to corrosion or tarnish by sul-

DIE CAST AIR VALVES FOR TRUCK-CRANES



The die cast valve is the nerve center

One of the outstanding features of the truck-crane shown above is the air control for handling all crane and shovel movements with air clutches. Two pressure valves represent the nerve center of the control system, and each of these valves (see inset) consists principally of five zinc alloy die castings as shown at the bottom of the illustration.

The manufacturer says: "The housing is now die cast in two pieces, and the machine time has been reduced to but a fraction of the former cost. In addition, there are three other vital parts of this assembly die cast of zinc alloy, and all of these parts have shown an equal saving over the former machined method of manufacture . . . all but the simplest of machine operations have been eliminated completely."

RADIO CONNECTORS FOR WAR PLANES

A war plane with faulty radio equipment is seriously handicapped and, for this reason, precautions must be taken to insure rapid repair and maintenance. The cable plugs illustrated below (left) are employed to permit quick disconnection and connection of various radio units. The plugs fit into mating sockets in the same manner as radio tubes, and are locked in place by a few twists of the knurled bands.

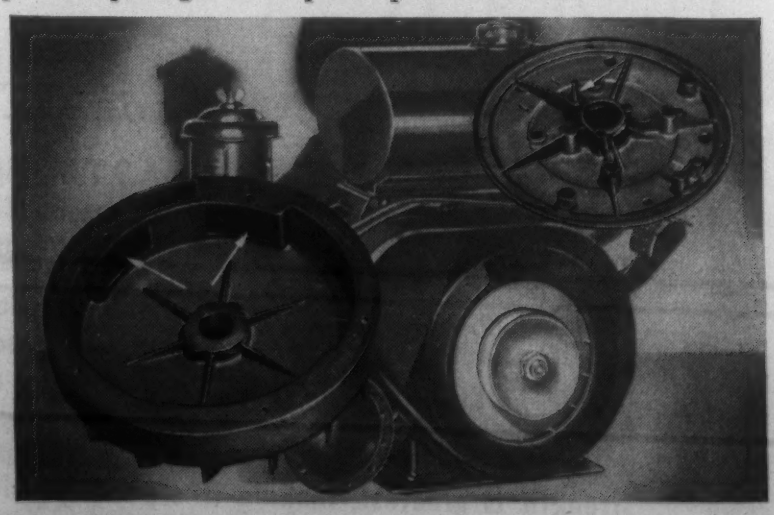
The housings of each of the three sizes of connectors shown are one-piece zinc alloy die castings. The knurling and the threads are obtained in the casting operation.

These cable plugs meet army specifications

INSERTS IN ZINC ALLOY DIE CASTINGS

The two zinc alloy die castings used in the flywheel magneto assembly of a well known 4-cycle engine (below) provide interesting examples of the use of inserts in the die casting process. There are two magnetic pole pieces and an alloy steel permanent magnet cast as inserts in the rotating part of the ignition magneto, and the armature plate has a steel pin so cast.

Aside from electrical properties, inserts of various materials are used in zinc alloy die castings to provide superior bearing surfaces, greater hardness or wear resistance, heat and electrical insulation, ductility and other properties not possessed in the casting itself. Inserts are also used to provide passages or shapes of parts which cannot be cored.



Magnetic elements inserted in one casting—a steel pin in the other

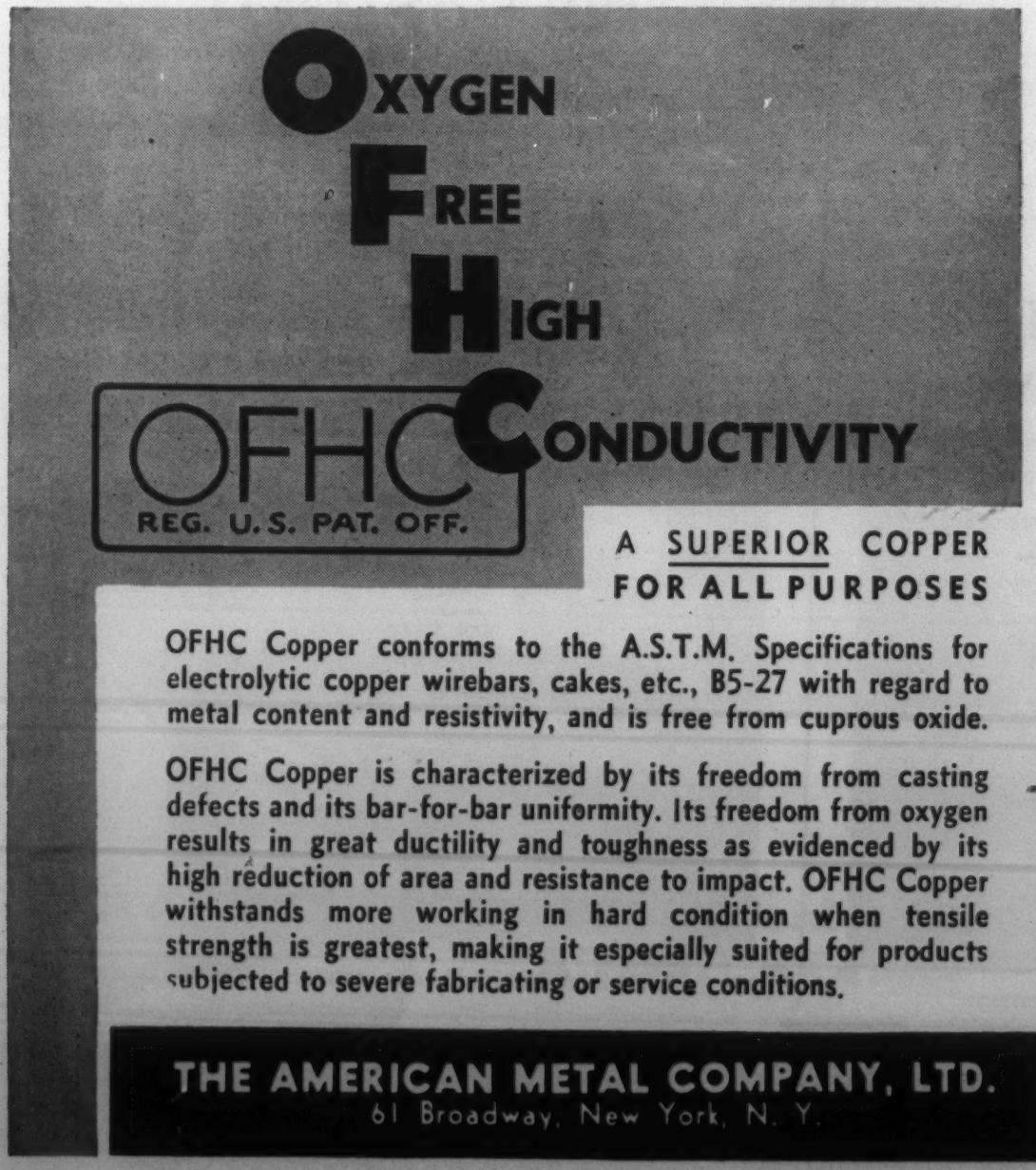
THE New Jersey zinc° ALLOY POT

FOR VICTORY BUY UNITED STATES WAR SAVINGS BONDS STAMPS

A publication issued for many years by The New Jersey Zinc Company to report on trends and accomplishments in the field of die castings. Title Reg. U. S. Pat. Off.

METALS AND ALLOYS EDITION No. 10

THE NEW JERSEY ZINC COMPANY 160 FRONT ST., NEW YORK CITY
HORSE HEAD SPECIAL (99.99 + % Uniform Quality) ZINC



phur fumes. It is attacked by concentrated nitric acid.

It has a marked affinity for hydrogen, being capable of dissolving 800 volumes at room temperature. This property makes it useful as a catalyst for hydrogenation reactions, and for removing hydrogen from a mixture of gases in gas analysis.

In 1940, of the 70,000 ounces consumed in the U. S., about 50 per cent was used in electrical contacts where the requirements are resistance to corrosion and abrasion and the necessity of withstanding a high arcing current. About 40 per cent was used in dentistry. The remaining 10 per cent was used in chemical, jewelry and other industries, *e.g.*, electroplating. Alloys of palladium with copper, silver, gold, nickel, cobalt, rhodium, iron, etc., are used.

Palladium plating solutions used in the past are not very satisfactory. The plating solution patented by Pilet in 1884, which is described in this paper, is best known. It has the disadvantage of a short life due to build-up of chloride in the bath as the result of replenishment of the palladium content with palladous chloride.

Keitel and Zschiegner have improved the bath by substituting palladium ammino-nitrite $Pd(NH_3)_2(NO_2)_2$ for palladous chloride. Disadvantages of the resulting plating solution are low plating rate and difficulty of control.

A new type of palladium plating bath, sold under the trade-name "Pallite," is stated to be free from the above disadvantages. With this solution, dense, adherent, dull gray deposits of any thickness can be produced. Polishing will produce a bright surface.

—Geo. C. Lambros, *Metal Finishing*, Vol. 41, 1943, pp. 73-76.

Automotive Substitute Materials

Condensed from "S.A.E. Journal"

In making substitutions, some items will require extensive tests to determine whether substitutes should be released or not, while other items can be decided upon in the drafting room. Each substitution must be considered individually.

Numerous satisfactory substitutes have become unavailable, necessitating further study. Slight changes in design or changes in production methods often made a lower grade material satisfactory, where substitution alone without modification of design or treatment did not produce an acceptable result.

For example, in making substitutions for a critical alloy steel used in a truck steering knuckle, accelerated fatigue tests on sample parts were carried out in the laboratory on stroking machines. Several satisfactory materials were found, but their supply was limited. One steel, which was considered unsatisfactory, gave very good results when the radii of the fillets were increased and the quality of the machining in the fillets was improved. These changes were adopted in the further tests. NE 8744 was considered borderline, but samples shot blasted at all areas subject to stress concentrations had fatigue lives far greater than any of the other materials tested.

Steering knuckles were developed of

St. Joe electric shovel operating in a St. Joseph Lead Co. mine in Missouri

LEAD — The Preserver of Steel

Lead is one of the few metals now available.

Steel is in tremendous demand for wartime needs.

Lead's greatest strength is its ability to withstand corrosion.

The "Achilles' Heel" of steel is its poor defense against rust.

It is logical to protect the critical material with an available metal which can supply that protection.

Today, lead protects steel not only as a paint pigment, but as a metallic coating.

Pole-line hardware is now given a hot-dip coating of lead.

At least two important steel companies are now producing lead-coated steel sheets:

The Continental Steel Corporation, Kokomo, Indiana;
The Weirton Steel Company, Weirton, West Virginia.

The property of lead which enabled a lead pipe to withstand the elements for 1800 years, is now recognized as armor for the "Achilles' Heel" of steel.

ST. JOSEPH LEAD COMPANY

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Lead	*Zinc Oxide*	*Antimony*
Zinc	*Antimonial Lead*	*Cadmium*

THE LARGEST PRODUCER OF LEAD IN THE UNITED STATES

much less critical material than originally used and having a greater fatigue life than original production. The minor design changes and improvement in machining the fillets were a major help in improving fatigue life.

How Processing Affects Substitution

No production equipment was available for shot blasting, and, since combinations without shot blasting were satisfactory, this operation was not used in production for manufacturing steering knuckles. It was used, however, in manufacturing transmission gears, as other changes in processing and heat-treating substitutes were of little value in improving fatigue life.

Another aid in the development of substitutes was the use of a non-burning type of carburizer containing no charcoal. It produced deeper and more uniform penetration. This material is produced by pulverizing coal, mixing the energizing chemicals thoroughly through it, sintering into briquettes at 2000 deg. F., and breaking the briquettes into kernels of the proper size.

For some parts there are no satisfactory commercial alternatives; for example, material used for drain-cocks, copper in electrical units, and steels for valves or similar items subjected to high temperatures. Shorter service life must be accepted in some cases, such as steel cooling fins of radiators and valve steels with a lower percentage of scarce elements.

In the Chevrolet 4 x 4 Army 1½-ton truck, 129 items made of copper or its alloys have been replaced by lead, felt, steel, iron, plastics, die castings, malleable iron, compressed iron, granodizing, cactus fiber, and cadmium, zinc, and terne plate, or have been eliminated entirely by other changes.

Fifty-seven items made of tin and its alloys have been replaced by leather, felt, steel, iron, granodizing, lead coating, paint, and compressed iron, or using welding instead of soldering and lower tin content in the alloy.

Sixty items made of nickel and chromium alloys have been replaced by steels which use very little nickel and chromium or none at all. Regarding production of war materials, the limit of substitution has not been reached. Progress from now on, and how far we must go, will depend entirely upon the supply of materials. With regard to post-war possibilities, economics will be the principal factor.

—John G. Wood & R. F. Sanders, *S.A.E. Journal*, Vol. 51, March 1943, Trans. pages 78-83, 93.

Permanent Magnet Alloys

Condensed from "Archiv Eisenhüttenwesen"

The principles of the design of magnet systems in electric measuring instruments are discussed and the essentials for their calculation described; the aim is to produce a maximum of magnetic capacity with a minimum amount of steel. A standardization [from the German standpoint] to reduce the present multiplicity of forms is advocated. The magnet alloys most used in Germany at present are given in the Table.

The data in the magnetic properties columns represent (1) the magnetic energy (B x H) max. in ergs/cm.^{3} omitting decimals; (2) permeability at the most favorable point of working in Gauss/Oersted; (3) area constant of hysteresis loop in per cent.

—H. Bumann, *Arch. Eisenhüttenw.*, Vol. 15, June 1942, pp. 547-549.

Composition in %						Magnetic properties			Ratio of length to section in airgap
Al	Cr	Co	Mo	Ni	Others	(1)	(2)	(3)	
—	6	—	—	—	—	12	175	46	23
—	9	6.5	1.4	or	1.6W	21	079	46	13.5
—	9	11	1.6	—	—	25	053	44	11
—	9	16	1.6	—	—	28	045	44	9.5
12	—	—	—	22	—	31	037	47	8
—	5	31	0.6	—	5W	40	043	45	9
12	—	3.5	—	22	—	43	028	46	6
14.5	—	—	—	28	—	50	013	38	4
14	—	11	—	24	5Cu	66	010	36	3-3.5
7	—	35	—	17	10Ti	90	010	39	3
10	—	22	—	16	—	190	023	70	5.5

Better Castings—by SHENANGO-PENN

Centrifugal Process

FOR the engineer who is looking for additional facilities to produce bushings, bearings, pump and cylinder liners, sleeves, etc., these are some of the advantages which Shenango-Penn centrifugal castings can offer:

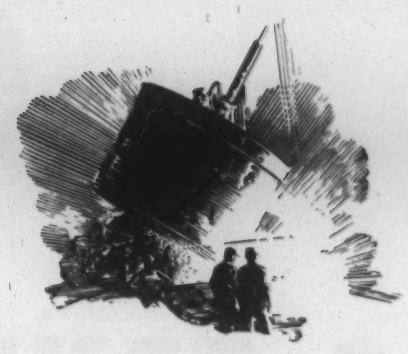
1. **Wide range of sizes:** Tubular bars from 2″ to 26″ O.D. and up to 26 ft. in length. Solid bars from ½″ to 8″ O.D. in 6 ft. lengths.
2. **Uniform density:** Products have a fine, even grain structure. Brinell hardness usually 2 to 5 points more for the same analysis.
3. **Less machining time:** Smaller allowance for finish means less wastage of material and lower machining costs.

If you have a tough casting problem, perhaps we can help you solve it. Won't you write us if you want more information?

SHENANGO-PENN MOLD COMPANY
1508 WEST THIRD STREET • DOVER, OHIO
Executive Offices: Pittsburgh, Pa.

SHENANGO-PENN

ALL BRONZES • MONEL METAL • ALLOY IRONS



STAINLESS STEEL

STAINLESS steel is playing an important role in Allied war production. Our aircraft, warships and motorized units utilize this strategic material. Production of chemicals, explosives and synthetic rubber is facilitated by use of stainless steel equipment. In many other fields, where high tensile strength and resistance to heat or corrosion are demanded, stainless steel is specified.

As America's largest and only exclusive producer of stainless steel, Rustless is filling a substantial portion of these wartime needs. Rustless is doing more. Through use of its unique process, Rustless is conserving America's limited resources of chromium and electrolytic nickel. This is important, because the stainless steel industry is the largest consumer of low-carbon ferrochrome and electrolytic nickel, both of which are among the most critical of strategic materials.

The Rustless Process is based on the use of sub-grade chrome ore and stainless steel scrap, of which there are adequate supplies in this country. More than 65% of the nickel used by Rustless is obtained from scrap, while only 3% of its chromium comes from low-carbon ferrochrome. Thus Rustless is not only meeting wartime demands, but through its conservation efforts is also assisting greatly in meeting the critical supply problem of these two metals.

These advantages of the Rustless Process will be of equal benefit in meeting a greatly expanded use of stainless steel after the war. When that time comes, Rustless will be ready with a fund of new technical knowledge and specialized experience to devote to the problems of peace.

RUSTLESS IRON AND STEEL CORPORATION, BALTIMORE, MD.

RUSTLESS

CORROSION AND HEAT-RESISTING STAINLESS STEELS

Testing, Inspection and Control

Specifications • Physical and Mechanical Property Testing and Inspection • Routine Control and Instrumentation • Radiography and Magnetic Inspection, Spectrographic and Photoelastic Analysis • Corrosion- and Wear-Testing • Examination of Coatings • Surface Measurements • Metallographic Inspection and Technique

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Photoelectric Pyrometers

Condensed from a paper before The Electrochemical Society

Solid photoelectric cells can be used to advantage in the measurement and control of temperature. "Photoelectric Pyrometers" are similar to both optical and total radiation pyrometers in that they measure the radiant flux from a body, whereas other temperature-measuring devices attain, by conduction, a temperature equal to that of the body. Therefore they function best at relatively high temperatures. Total radiation pyrometers evaluate radiant flux equally for all wave lengths; optical pyrometers, in proportion to the spectral sensitivity of the human eye; and photoelectric pyrometers, in proportion to the spectral sensitivity of the photocell or cells.

Photoelectric pyrometers using a single solid-photocell convert radiant energy into photoelectric current which can be measured directly or used to operate control mechanisms. Spectrally, they function more like optical pyrometers as they utilize only visible or near visible energy. Electrically, they are more like total radiation prometers as they generate electricity and can be used for automatic control.

Advantages and Limitations

The advantages of using a solid type photocell instead of a phototube for industrial pyrometers are: (1) Ruggedness; (2) spectral similarity of cells of one type, aiding replacement because of interchangeability of cells; (3) spectral stability, necessary for maintaining calibration; (4) electrical stability, resulting in greater accuracy; (5) a relatively long life; and (6) freedom from outside circuit fluctuations, due to the solid cell being self-generative.

Data on the relative sensitivity of the Type 3 Photronic cell show it is basically many times more sensitive than a total radiation pyrometer. This is advantageous in temperature control and the fact that photoelectric pyrometers can be used for control is an advantage in itself. Another advantage is the rapid response to changes of temperature, made use of in continuous strip mills and other control processes where the material is in rapid motion and the temperature varies rapidly. Photronic cells of one type are so sufficiently alike that, with care in pre-selection, calibration data based on theory are more accurate and less troublesome than point to point physical calibration. With the physical design of the pyrometer fixed, the sensitivity of a standardized instrument or recorder can be adjusted to the effective sensitivity of a cell by a pre-calibrated plug-in resistor.

One limitation of solid-cell pyrometers is that they are restricted in use to temperatures above 1700 or 1800 deg. F. Another is that to prevent the cell from over-heating a water jacket or air blast is required to keep a maximum cell temperature of 50 or 60 deg. C. (120 or 140 deg. F.). Heat-absorbing glass filters may be needed. High sensitivity may also at times be a disadvantage as the expanded scale limits a single range indicating in-

RADIOGRAPHY

with PICKER 250 KV. X-RAY UNIT

The design and construction of Picker 250 kv industrial x-ray units are based on an exhaustive study of the requirements of a great variety of industries needing non-destructive examination of their production.

The wide range of voltage—30 to 250 kv—gives these units a large field of usefulness. They provide complete radiographic facilities for a variety of materials and section thicknesses, from small light alloy castings up to three inches of steel without screens, or four inches of steel with screens.

The transformer-tube unit may be mounted on a mobile chassis, carried on an overhead or jib crane, or mounted on a dolly, thus providing suitable facilities for radiographic work in foundries, for pressure vessels, steel pipe welds, or assemblies.

The fine focus tube, with its low absorption radiation window, permits a degree of sensitivity heretofore unattained in industrial radiography.

☆ ☆ ☆

During 64 years of experience in the manufacture of high voltage apparatus, Picker-Waite engineers have pioneered many major developments in x-ray design and construction.

PICKER X-RAY CORPORATION

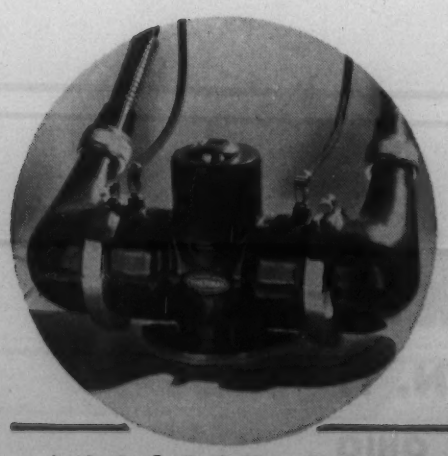
300 FOURTH AVENUE, NEW YORK, N. Y.

WAITE MANUFACTURING DIVISION, CLEVELAND, OHIO

MANUFACTURERS OF HIGH VOLTAGE APPARATUS SINCE 1879

Dispatches from the African Desert and other far-flung United Nations' battlefronts pay tribute constantly to the superiority of Allied aircraft. The X-Ray has played an important part in the development of the high degree of mechanical efficiency evident in design, construction, and performance of these planes. X-Ray analysis of molecular structure aids in the development of stronger alloys; X-Ray inspection of vital parts eliminates the need for excess "safety factor" to compensate for possible hidden flaws; the resultant reduction in weight means better maneuverability, superior combat performance, that have brought many a victory to our fliers at the front. The greater strength and reliability have prevented many a crack-up.

After the war, many industries will profit from these wartime lessons. Untold new fields of accomplishment will open to the design engineer who knows how to eliminate the "ignorance factor", the unnecessary extra weight, from his design considerations. The X-Ray will lead the way to more and better products of every mechanical variety.



THE X-RAY TUBE IS THE HEART OF THE X-RAY MACHINE...
The majority of leading makes of X-Ray apparatus are equipped with Machlett Tubes.

MACHLETT
Laboratories Inc.
SPRINGDALE CONNECTICUT

LARGEST PRODUCERS OF X-RAY TUBES
X-RAY TUBE SPECIALISTS SINCE 1898

strument to a total change of 300 or 400 deg. F. Lenses, filters, and cell-windows must be kept clean.

Applications

So far photoelectric pyrometers have been used chiefly in the steel industry, for measuring temperature in the combustion chamber, metal bath, and regenerator zones of open-hearth furnaces. Also rolling and welding temperatures have been measured, and open-hearth roof and continuous strip mill temperatures recorded. Many applications in the non-ferrous alloy and ceramic industries will be able to use them.

Sensitive indicating instruments, recorders and control relays must be used because the output of the cells is only a few micrometers. For temperatures below 2200 deg. F. and even higher where a well restricted angle of acceptance is used, it is necessary to amplify the cell current. The Model 721 Weston Photoelectric potentiometer, used extensively in the steel industry, is ideal. The amplified current it produces can be used to operate more rugged indicating instruments, recorders, or control relays. In fact all three may be operated at once. This potentiometer is almost instantaneous in its action.

—M. E. Fogle, *Trans. Electrochem. Soc.*, Vol. 83, 1943, Preprint 83-14, 9 pp.

Interpreting Jominy Test Results

Condensed from "The Iron Age"

When NE steels were first produced, and to save time, the Jominy hardness test was adopted to find out just what these steels would do.

A Jominy sample is machined to 1-in. round and 3⅞ in. long with a flange on one end 1¼ in. in diameter and ⅛ in. thick. It is normalized, machined to size and heated to quenching temperature for the steel being treated. It is then inserted in a hole in a fixture so that it hangs vertically on the flange, over a ½-in. round orifice which is ½ in. below the bottom end of the sample. Water comes through the orifice and pressure is allowed to continue until sample is practically cold.

Smooth flat surfaces are ground 0.015 in. deep, lengthwise on opposite sides of the sample. Rockwell hardness readings are taken at 1/16 in. intervals from the quench end.

Rate of quench is fast on the bottom and slow on the top. By Rockwell test from bottom to top the hardness developed by different rates of quench can be found.

Various interpretations of the Jominy and quench test for the determination of tensile strength, yield point, reduction of area and elongation will apply only to fully quenched steels ranging in hardness from about 200 to 400 Brinell. These interpretations do not apply to extremely hard steel, nor to steel which has been treated to below 200 Brinell, nor to steel that is annealed, normalized or in the "as rolled" condition.

—*Iron Age*, Vol. 151, Feb. 11, 1943, pp. 64-66.

Typical Applications

Problem: A New England war plant, purchasing steel castings from an outside source, was experiencing a reject rate of 75% after machining. Three man-hours were lost on each rejected unit.

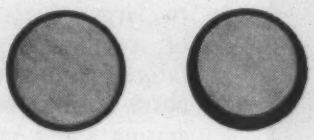
Solution: X-ray inspection.

Result: Defective castings detected before machining. Production accelerated. Tremendous saving effected in time, labor and materials.

Problem: Weight of bomber landing gear was excessive. Could weight be reduced without sacrifice of safety factor?

Solution: Analysis of stressed part with X-ray.

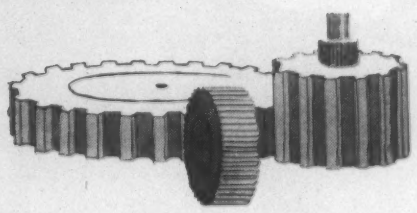
Result: Deadweight in casting safely reduced by 50%. Tons of critical material saved . . . load carrying capacity of plane increased.



Problem: Solenoid plunger in communications equipment wouldn't function properly. Engineers certified design as okay; factory said manufacture was okay; part appeared perfect.

Solution: Examination with X-ray.

Result: Picture disclosed that when machined, chromium plating on one side of plunger was heavier than on other—reducing its magnetic properties.



Problem: Inspectors questioned mesh and clearance between gears and housings in tab gear boxes for fighter planes. Only proof of accuracy was check of production drawings.

Solution: A look inside gear housing with X-ray.

Result: Inspectors given X-ray proof that each completed gear unit was constructed properly . . . or rejected before shipment.

Two Proposals

PROPOSAL NO. 1 Send for our new book on Industrial X-ray Inspection. The most complete book of its kind, it is packed with practical, understandable, question-answering information on how and where to use industrial X-ray inspection — how to set up an X-ray department — how to select the right equipment — range of equipment available. Ask for B-3159.

PROPOSAL NO. 2 If you want fast action on your problem just tell us to send a Westinghouse X-ray Specialist. He'll respond promptly—and competently.

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Stress Analysis of Engine Parts

Condensed from "S.A.E. Journal"

The old methods of design, based on large doses of empirical formulas reinforced by factors of safety, are inadequate in the fields of airplane and automobile engineering, where weight saving is an essential requirement. New methods, involving accurate stress measurements, are demanded.

The methods used in the Chrysler laboratories are described, examples of their application to design of engine parts are given, and their advantages and disadvantages are listed. Some of the stress problems in connection with crank-shaft development are discussed in detail.

Experimental methods of stress analysis are photoelasticity, "Stresscoat," extensometers, and electric strain gages. The principal types of engine problems which can be studied by these methods are evolution of a new design; determination of the cause of failure; and comparison of various designs. The experimental method of stress analysis is most effective in the last field. In the utilization of these methods, static tests, using simulated service loading, and dynamic tests under actual service conditions are the principal means of procedure.

Static load testing is usually the most convenient and generally favored because the problem of instrumentation is greatly simplified. However, the investigation is often conducted on the basis of loads which may or may not correspond to operating conditions. Dynamic load testing demands more complex instrumentation, and so far is less thoroughly developed.

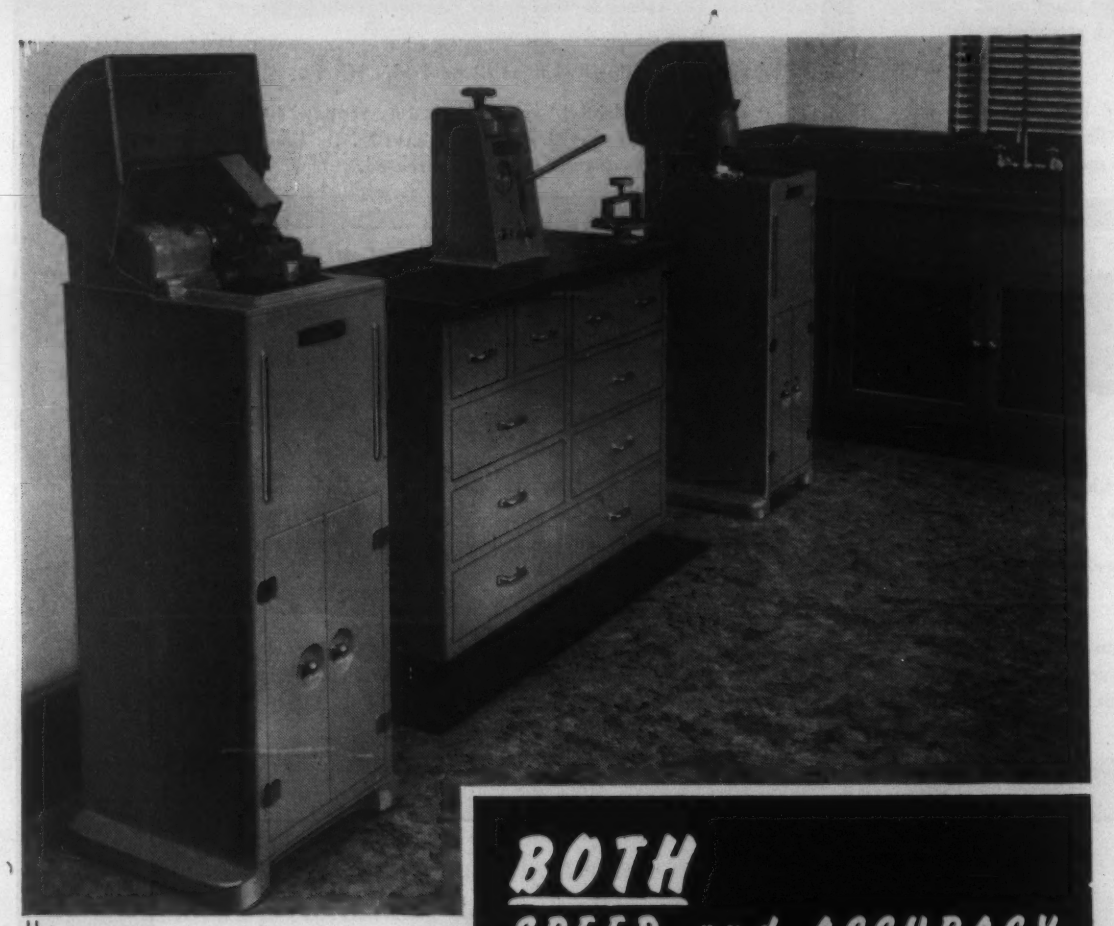
A comprehensive stress analysis investigation requires both phases of testing. Dynamic tests should establish the mode and magnitude of operating loads, while static measurements will determine the corresponding stresses. Refinements of instrumentation and technique are necessary to promote greater accuracy and speed, but this phase of experimental stress analysis is developing in a satisfactory manner.

Complete solution of the problem of design demands also knowledge of the properties of the material used. We know the least in this field and many features have yet to be studied and classified.

Essential information is still lacking regarding the influence of size when translating fatigue values from small specimens to larger parts; evaluation of the effect of combined stresses in terms of the fatigue information derived from rotating-beam testing; influence of preload and operating stress range on endurance life; effect of stress raisers on mechanical properties of materials; effect of manufacturing processes on endurance life; and mechanical properties at elevated temperatures.

Stress analysis, even in its as yet partially developed stage, can provide essential information involving strength of materials. As the technical and fundamental concepts are further developed, the goal of maximum strength at minimum cost and weight will come closer to realization.

—Charles Lipson, *S.A.E. Journal*, Vol. 51, April 1943, Trans. pages 105-124.



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PREPARING metallurgical specimens for microscopic examination is an increasingly important function in the inspection of alloys and metals for war purposes.

The need for faster methods and more accurate results is simultaneously created by the existing critical production situation . . . *and only modern equipment which embodies the latest automatic control and time saving principles can meet these war-borne demands!*

Equipment in the modern laboratory illustrated includes the Jarrett Submerged Specimen Cutter, the Jarrett Specimen Mounting Press and the Jarrett Metallographic Polishing Machine . . . Each unit is compact, self-contained and extremely simple to operate . . . each is specifically designed to speed specimen production, increase quality and reduce costs.

Write for the Jarrett Catalog of Modernized Equipment for the Metallurgical Laboratory

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Crack Detection in Welded Tubes

Condensed from "Engineer"

Experimental work has indicated that the following conditions must be satisfied if maximum sensitivity in the detection of cracks by electromagnetic means is to be obtained: (1) The welded structure should be painted with a flat white paint before the application of magnetic ink; (2) magnetizing current should be not less than 400 amp., and preferably 600 amp., and (3) lines of force should be produced in two directions at right angles.

Apparatus, designed by Reynolds Tube Co., Birmingham, consists of a step-down transformer with an output of 600 amp. at 6 volts, using 230-volt a.c. Before commencing work the switch is closed, allowing a.c. to pass from the lines to the apparatus. A single-pole, double-throw switch enables the use of either of the clamps for circumferential tests or of a single loop induction for longitudinal tests. This change-over switch is protected by electrical interlocking with the transformer primary circuit.

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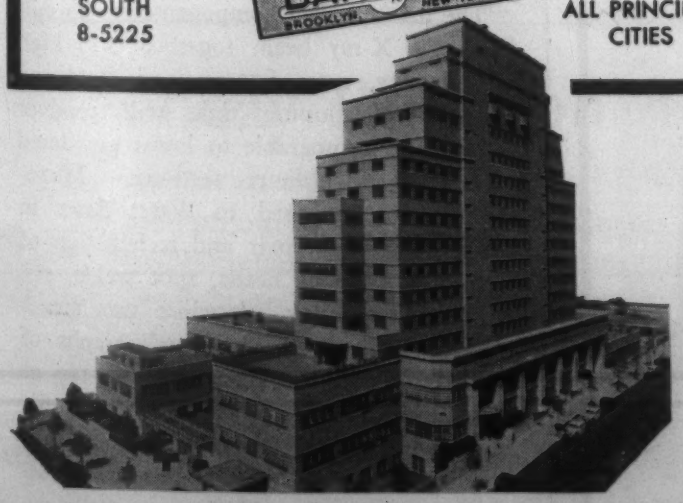

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GLASS-ELECTRODE pH INDICATOR—$160

Although simplified and stripped to essentials for low cost and easy operation, L&N's Glass-Electrode pH Indicator measures within a limit of error of ±0.1 pH. It includes everything necessary for measuring pH, and is also adaptable to titrations.

Speed and convenience are inherent. Adjustments take but a moment, and measurements are made by pouring the sample into the beaker and reading pH directly from the meter scale.

Outstanding advantages include:

1. Full accuracy in atmospheres of 95% relative humidity up to 85 F.
2. Manual temperature compensator eliminates computations, saving time and preventing errors.
3. Instrument is adequately shielded from electrical disturbances.
4. The double range, covering 0-8 and 6-14 pH, provides a convenient overlap of 2 pH . . . a desirable feature for titrations.
5. The scale is longer than in any comparable pH indicator.
6. The mahogany case is built to stand up under severe use. Wood and finish are unaffected by high humidity.
7. Batteries are separated from the electrical circuits to avoid corrosion from spent batteries.
8. A whole end of the box swings out, leaving the electrodes and sample holder easily accessible.
9. Glass electrode is adequately shielded against electrical effects.
10. Factory filled and sealed electrodes are highly stable.
11. The sample cup is a standard 50 ml beaker.
12. Fifteen-inch leads permit electrodes to be used external to the case, for titration as well as pH.
13. Light, well-balanced, and easily portable, the instrument case carries everything necessary for measurements.
14. Only 3 simple preliminary adjustments are necessary.
15. Maintenance is negligible, consisting of adding KCl to the salt bridge every 6 or 8 weeks, cleaning the electrodes occasionally, and replacing batteries at infrequent intervals.

7662-A1 GLASS-ELECTRODE pH INDICATOR ASSEMBLY

Ranges	0 to 8 pH, and 6 to 14 pH
Limit of Error	±0.1 pH, exclusive of any error in the buffer solution
Temperature Compensator	Range, 0 to 50 C
Price	$160.00

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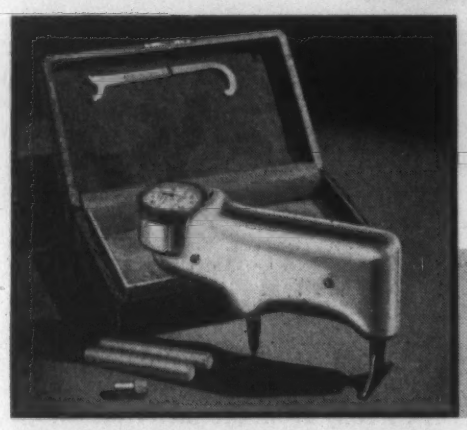

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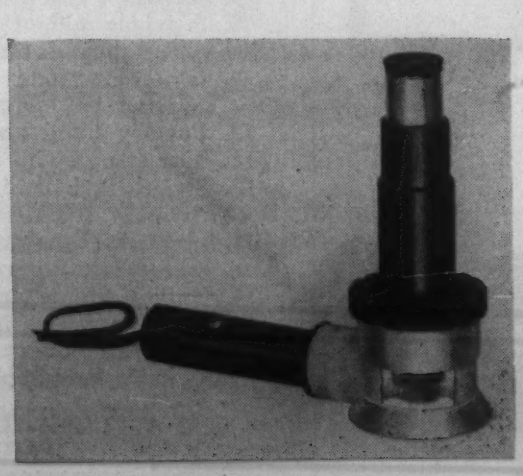

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either contact causes a metal plunger to rise and open a switch in the primary circuit. The primary circuit is broken before the blade finally leaves the contact, so that no current is passing when the secondary circuit is broken.

Additional control is provided by a contactor switch on the primary side of the transformer. Two pilot lights on each side of the panel indicate whether current is passing through the clamps or through the ring.

The ring clamp is constructed of light alloy and consists of a ring formed by two semi-circular jaws. One jaw is permanently fixed to the handle, but the other is pivoted on the hand grip. A trigger actuates the movable jaw. The pivot is surrounded by a box-like structure to which are attached the electric cables feeding each jaw. On the open end of the fixed jaw a hollow shield is mounted.

—*Engineer*, Vol. 175, Feb. 26, 1943, pp. 178-179.

Radiographic Inspection of Welds

Condensed from "Welding Journal"

X-ray spot checking of completed assemblies for controlling the quality of welding serves primarily as a warning to the welders not to relax in efforts toward prime quality. It is advantageous to bring the assembly to the established X-ray department, rather than use portable equipment.

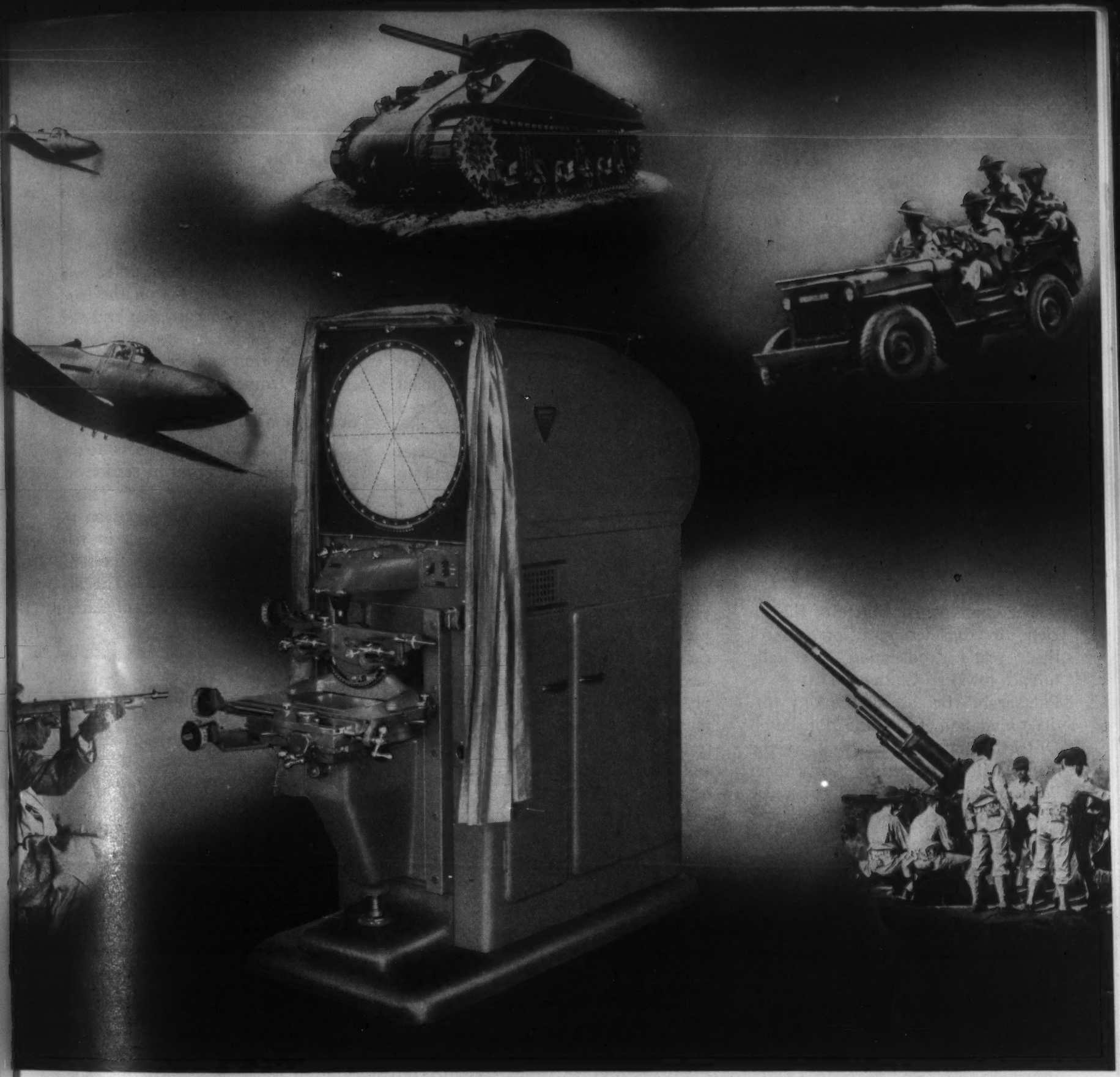
In the case of a million volt X-ray, the building facilities required are so large that even heavy tanks can be run into the X-ray room under their own power. Special techniques of radiography with the million volt machine of steel sections less than 1 in. thick indicate remarkable increase in contrast over that obtainable with the lower powered X-ray units.

The use of softer components of the million volt X-ray beam together with high film density, extra fine grained films and increased developing time will produce X-ray films comparable to lower powdered units on the thinner sections. Microradiographs are used to detect flaws in welds made for repair and reclamation of aluminum cylinder heads, spot welds, etc.

The radiographic procedure was standardized by means of microradiographs of a fine wire screen beneath and on top of alclad sheets of various thicknesses, the radiographs being taken at various tube to sample distances. The conditions necessary for maximum resolution are easily determined from the standardizing radiographs illustrated in the paper.

A fine focal spot X-ray tube is desirable if good resolution is to be obtained on the film for detection of small defects. Typical, excellent microradiographs made with the described technique are illustrated.

—Don M. McCutcheon, *Weldin Journay, N. Y.* Vol. 22, Jan. 1943, pp. 16-20.



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Throwing an accurate, sharply defined shadow image of the object under examination on a translucent screen, the B&L Contour Projector permits exact measurements or comparison with an enlarged template drawing at magnifications great enough for easy and accurate dimensioning.

Here again is a Bausch & Lomb peacetime development that serves America at War. The B&L Contour Measuring Projector is helping speed production of fighting tools for our fighting men.

For Bausch & Lomb Instruments essential to Victory—priorities govern delivery schedules.

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Annual Convention of the A.S.T.M.

— A Preview of the Program

For the first time in many years the annual meeting of the American Society for Testing Materials — the forty-sixth — will be held in Pittsburgh, Pa., at the William Penn Hotel, June 28 to July 2. Nearly every year, except when such annual conventions have been held in Chicago, Detroit, or some other mid-western center, these gatherings have assembled in Atlantic City, N. J. But with most of the suitable hotels requisitioned by the Army Air Corps, a meeting in that locality was out of the question.

The executive committee of the Society, in considering a location for this year's convention, naturally turned towards Chicago, Detroit or Pittsburgh. Because of the very cordial invitation from the Pittsburgh District Committee, as well as the many facilities offered by the William Penn Hotel, but primarily because Pittsburgh is very close to the center of gravity of A.S.T.M. membership, the committee decided on Pittsburgh for this year's general convention.

There has always been a large and active group of members in the Pittsburgh area, but while a predominant portion of these are mainly concerned with the metals field, there is a surprising number of diverse industries in that general locality interested in the Society's work.

The Technical Programs

About 100 technical papers and reports have been scheduled for this year's convention. To provide ample time for the presentation and discussion of these, 15 technical sessions have been arranged. These cover all phases of the Society's work — ferrous and non-ferrous metals, electrodeposited coatings, plastics, cement and concrete, soils, water, rubber, petroleum products, etc.

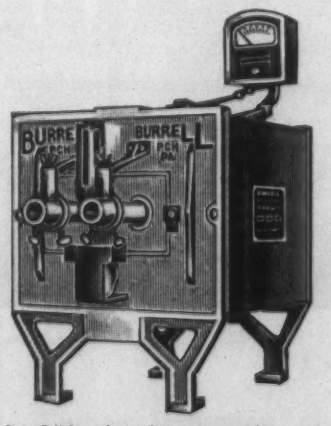
In this brief account of the chief activities, only those concerned with metals are reviewed — on the hardness of metals, on corrosion and electrodeposited metals, on non-ferrous metals, on iron and steel, and on the effect of temperature and fatigue.

Symposium on Hardness

A symposium on hardness testing will feature the fourth session on Tuesday evening, June 29. This is part of a series of discussions on the significance of various tests in relation to design. The first in the series was held 3 years ago — "The Significance of Tension Tests of Metals in Relation to Design."

This year's symposium has been developed by Prof. J. M. Lessells, of the Massachusetts Institute of Technology. He will present an introductory discussion and notes. The papers scheduled include:

"The Value of the Indentation Hardness Test," by J. M. Lessells.



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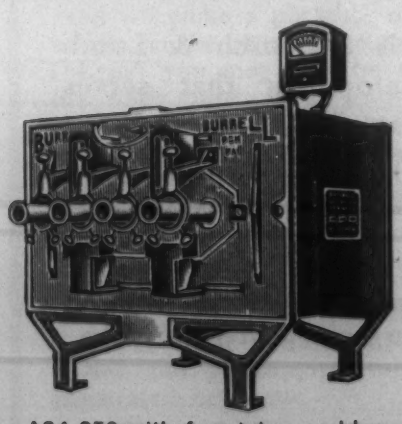

A24-950 with four tubes enables one man to run 125 "carbons" in 8 hours.

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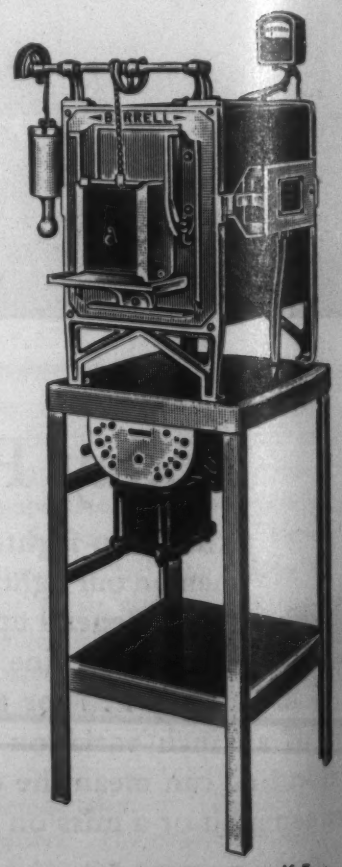
MODERN ACCESSORIES—Tap transformers modernize and simplify heat control. Pyrometers with rare metal thermocouples continuously indicate operating temperatures.

QUICK ELEMENT CHANGE—The non-metallic heating elements (no nickel or chromium) are silicon carbide rods which can be changed conveniently without dismantling the furnace.

CATALOG F-241—See the new box, muffle, tube, and pit type furnaces which provide convenient working chambers for a wide variety of heating operations in laboratories and pilot plants. Special high temperature furnaces are built to order.



A37-440 Burrell Box Type K Furnaces have been found convenient for all manner of heating operations in laboratories and pilot plants.

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The New Inspection Method Now Ready to Speed Your Output of Perfect Parts [NON-MAGNETIC AS WELL AS MAGNETIC]

An Informative Bulletin Also Ready

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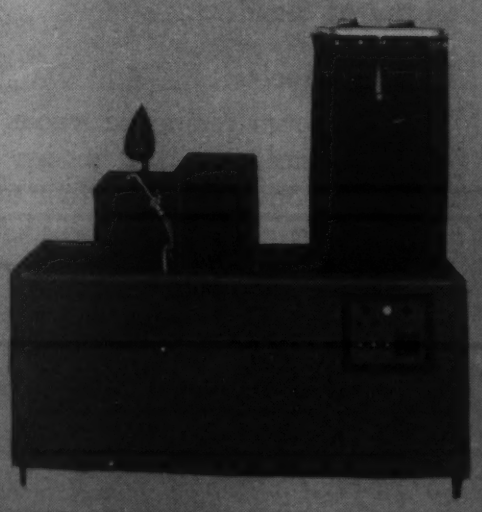
In the illustration, here, of aluminum castings—dipped in a penetrant fluorescent liquid, then rinsed, dried powdered and observed under black light—serious shrinkage cracks were shown up. The glowing fluorescent indications signal the exact locations in which the penetrant remained during rinsing, then developed finally on the surface under capillary action by the powder.

Zyglo, with its laboratory years behind it, has met the test of the production line with thoroughly practical results: *Clear, easily interpreted indications. Routine handling without delaying the flow of work. Big direct savings of labor, wasted when defective parts are assembled. Enormous indirect savings through prevention of failures.*

To fit Zyglo, into the routine of factory or overhaul shops a line of equipment has been developed. A complete compact unit and an arrangement of larger capacity units are shown below to indicate the range of accessories. Not only the practical equipment is available to licensed Zyglo users, but the full Magnaflux Service. This amounts to a continuing consulting and engineering service on flaw detection.

A great percentage of American manufacturing will find applications for Zyglo in the competition of the final war and early postwar years. You are urged to contact the Magnaflux Corporation to determine definitely the advantage of Zyglo in your plant. Write, requesting the new Zyglo Bulletin.



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"Present Types of Hardness Tests," by S. R. Williams, of Amherst College.

"Fundamentals of Hardness Testing," by S. L. Hoyt, of Battelle Memorial Institute.

"Some Limitations of Our Present Hardness Testing Methods," by J. O. Almen, of General Motors Research Laboratory.

Corrosion and Electrodeposited Coatings

The sixth session on Wednesday morning, June 30, features reports of two A.S.T.M. committees — B-3 on Corrosion of Non-Ferrous Metals and Alloys, and A-5 on Corrosion of Iron and Steel. Two technical papers are included:

"Atmospheric Corrosion of Copper," by A. W. Tracy, D. H. Thompson and John R. Freeman, Jr., all of the American Brass Co.

"The Total Immersion Corrosion Test," by W. A. Wesley, of The International Nickel Co.

The part of the session devoted to electrodeposited coatings will feature four technical papers, besides a report of Committee B-8 on Electrodeposited Metallic Coatings. The papers are as follows:

"Chromium Plate in Engineering Applications — Its Thickness and Finishing," by T. G. Coyle, of United Chromium, Inc.

"Properties of Plated Lead Coatings on Steel," by Gustaf Soderberg, of the Udylite Corp.

"Factors Underlying Specifications for Electrodeposited Metallic Coatings," by Edwin M. Baker, of the University of Michigan.

"Use and Misuse of the Salt Spray Test as Applied to Electrodeposited Metallic Finishes," by C. H. Sample, of the Bell Telephone Laboratories.

Non-Ferrous Metals

The sole topic for the session on Wednesday afternoon, June 30, is non-ferrous metals. Besides reports of seven committees, five technical papers are to be presented. These are as follows:

"Lead-Alloy Coated Copper Wire for Electrical Conductors," by C. J. Snyder, of Anaconda Wire and Cable Co.

"A Comparison of the Performance of Anodic Coatings on Aluminum Alloys by Salt Spray Test and by Weather Exposure," by Junius D. Edwards, of Aluminum Co. of America.

"Experiments on Plastic Bending for Aluminum Alloy 17S-T," by Joseph Marin, of Pennsylvania State College, and F. D. Cotterman, of Crane Co.

"Conservation of Tin and Soft Solders," by D. L. Colwell and W. C. Lang, of the Materials Branch, Conservation Division, WPB.

"Short-Time Tests of Low-Tin Solders Listed in Recent Federal Specifications," by J. A. Kies, W. F. Roeser and S. K. Gutterman, of the National Bureau of Standards.

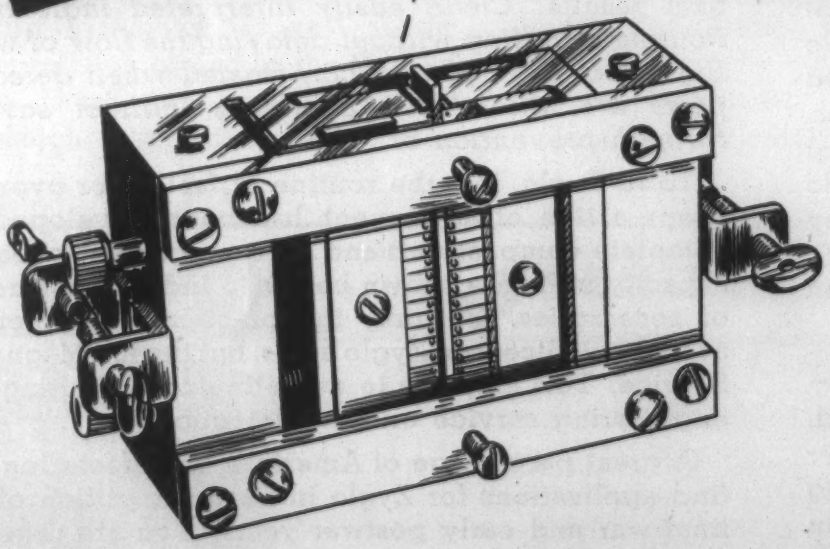
Iron and Steel

Besides seven committee reports on iron and steel for the session on Thursday morning, July 1, four technical papers have been scheduled. Among these may be mentioned:

"A Test for Measuring the Drawability of Deep-Drawing Steels," by Francis W. Boulger and F. B. Dahle, of Battelle Memorial Institute.

"The Strain Aging of Killed Low-Carbon Steel with Particular Reference to the Effect of Titanium," by George F. Comstock, of the Titanium Alloy Mfg. Co.

FOR **Determining Compression Yield Strength** IN SHEET METAL



A new jig for the determination of compression yield strength in aircraft design has been developed by W. P. Montgomery and R. L. Templin and is now available from stock from Baldwin Southwark.

With the Montgomery-Templin jig it is possible to test a single thickness of sheet in compression by supporting the sheet in the jig, as shown in the illustration, with a multiplicity of small rollers. Extensometers are attached to the edges of the sheet.

This new method makes it unnecessary to test the sheets in packs. It therefore requires a smaller load and simplifies the technique of testing to a large extent. The Montgomery-Templin jig—simple and inexpensive—reduces the apparatus to its lowest terms.

Baldwin Southwark Division, The Baldwin Locomotive Works, Philadelphia; Pacific Coast Representative, The Pelton Water Wheel Co., San Francisco.

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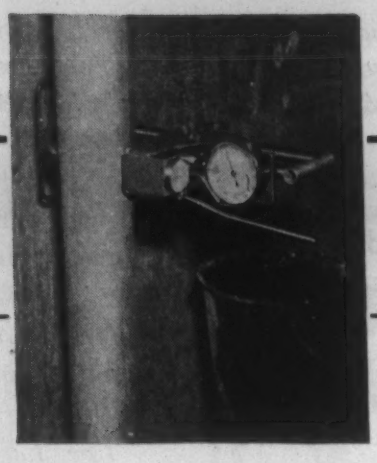

THE KING

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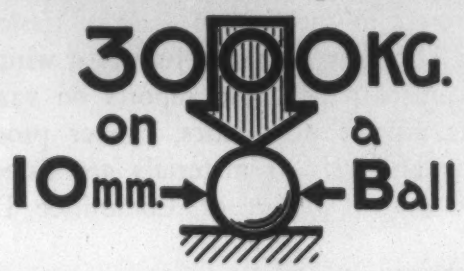
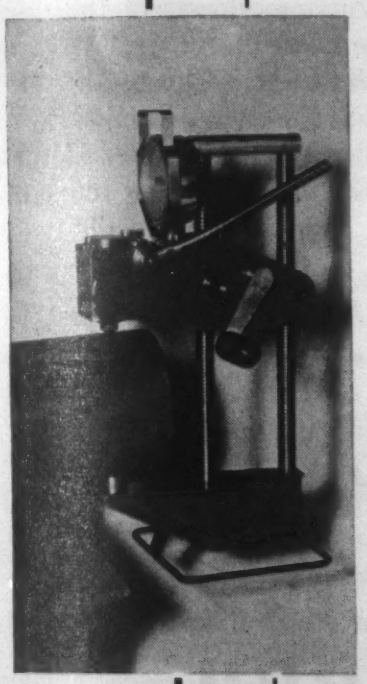
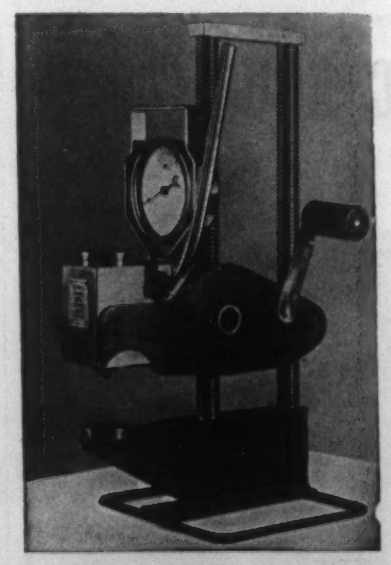


required to make a REAL BRINELL HARDNESS TEST

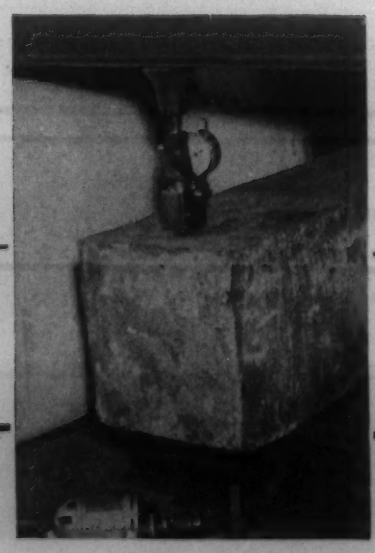


The KING PORTABLE BRINELL is an all around Brinell Tester, STATIONARY as well as PORTABLE. Its portability makes it indispensable for large parts and for saving time.

Throat 4" deep
Gap 10" high—Wt. 26 lb.



ANDREW KING—NARBERTH, PENNA.



"Structure and Creep Characteristics of Cast Carbon-Molybdenum Steel at 950 deg. F.", by H. E. Montgomery and John Urban, of the Lunkenheimer Co.

Effect of Temperature and Fatigue

One of the most interesting sessions involving the metals field is pointed to as that on effect of temperature and fatigue. This is scheduled for the afternoon of Thursday, July 1. Besides several committee reports, a number of important papers are listed for this session. Among these may be mentioned:

"The Technical Cohesive Strength and Other Mechanical Properties of Metals at Low Temperature," by D. J. McAdam, Jr. and R. W. Mebs, of the National Bureau of Standards.

"The Effect of Temperature on the Transition from a Ductile to a Brittle Type of Fracture in Several Low-Alloy Steels," by Paul G. Jones, of the University of Illinois.

"Interpretation of Creep - Test Data," by P. G. McVetty, of Westinghouse Electric & Mfg. Co.

"A New Chart for Estimating Working Stresses of Alloys at Elevated Temperatures," by A. Nadai and P. G. McVetty, of Westinghouse Electric & Mfg. Co.

Besides the foregoing papers dealing with temperatures, there are also several in the field of fatigue:

"The Effect of Overstressing and Understressing in Fatigue," by J. B. Kommers, of the University of Wisconsin.

"The Fatigue Properties of Some Cold-Drawn Nickel Alloy Wires," by John N. Kenyon, of Columbia University.

"Fatigue Tests on Some Copper Alloys in Wire Form," by H. L. Burghoff and A. I. Blank, of the Chase Brass and Copper Co.

Plastics

Some attention is devoted to plastics, a field of at least competitive interest to metal men. At a session on Thursday morning, July 1, at which technical papers and reports on various aspects of plastics, rubber products and related materials are listed, the annual report of Committee D-20 on Plastics will be presented. It outlines extensive work under way, and submits for action by the Society requirements for injection molding compounds and tests for shear and flexural strength of plastics.

Two technical papers to be presented are:

"Impact Testing of Plastics — I. Energy Considerations," by David Telfair and Howard K. Nason, of the Monsanto Chemical Co.

"The Relation Between Repeated Blow Impact Tests and Fatigue Tests," by William N. Findley, of the University of Illinois, and Otto E. Hintz, of the Radio Corp. of America.

The General Session

The Pittsburgh local committee is planning to have one or more outstanding speakers at the Society's general session on Wednesday evening, June 30. Announcements of the details will be made later.

Besides the presentation of the reports of the Society's administrative committees, the Dudley Medal for 1943 will be awarded at this session. H. J. Ball, professor of textile en-

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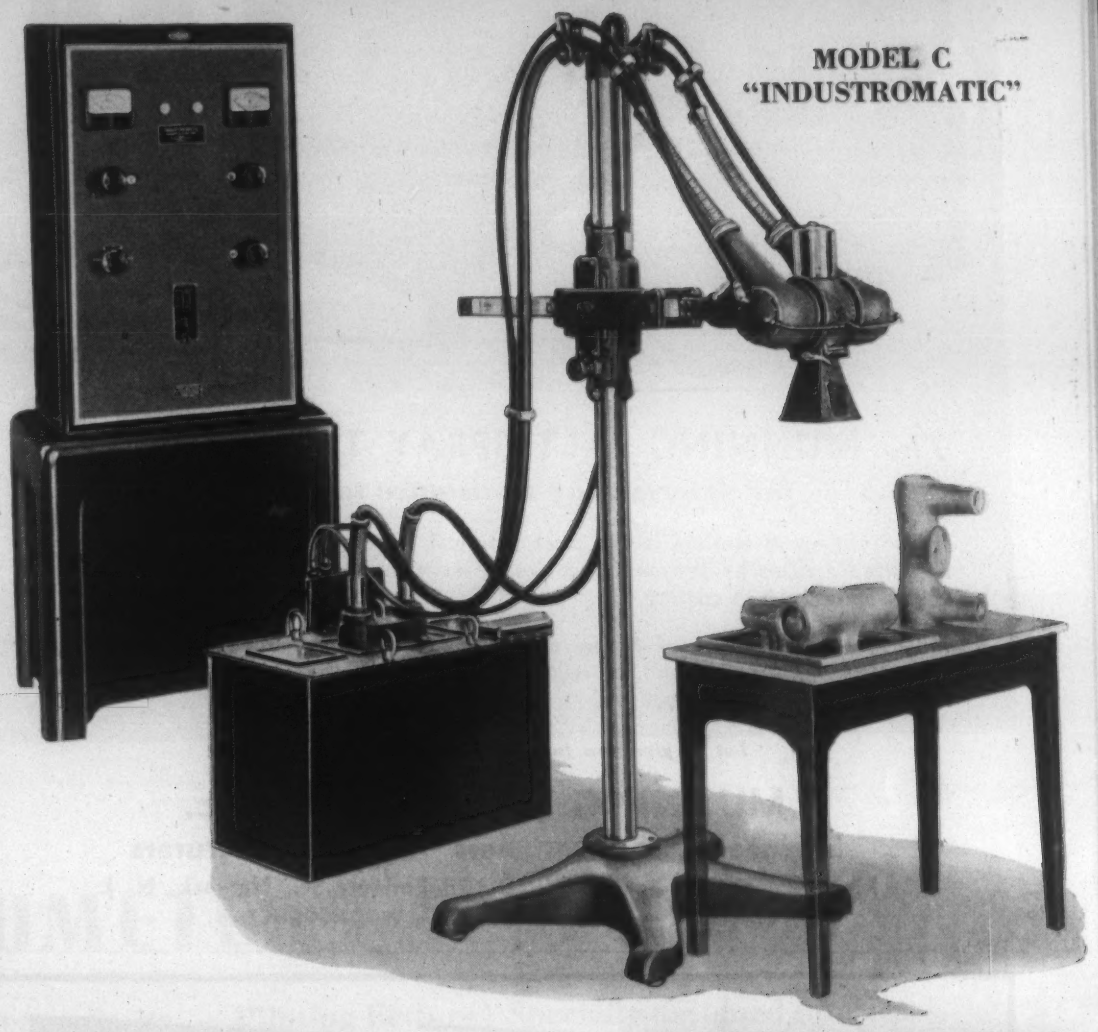

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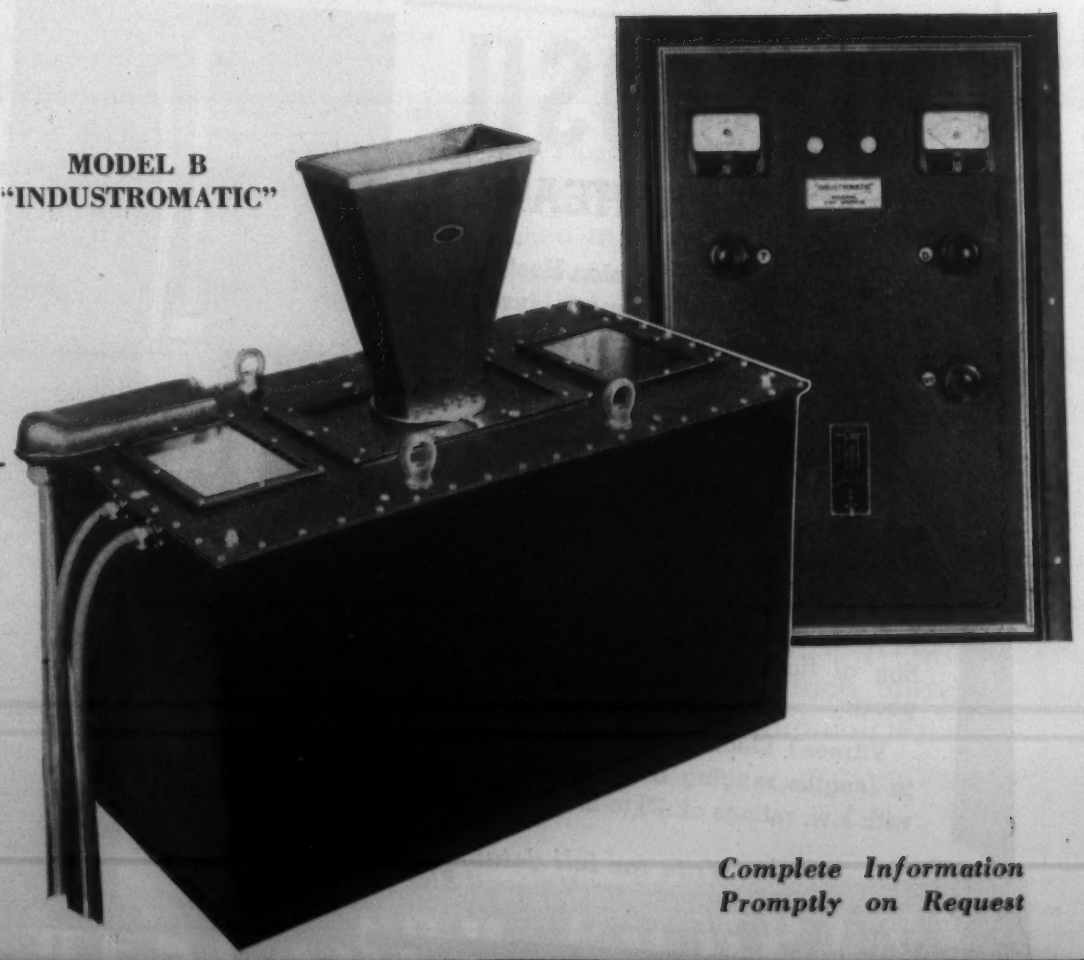

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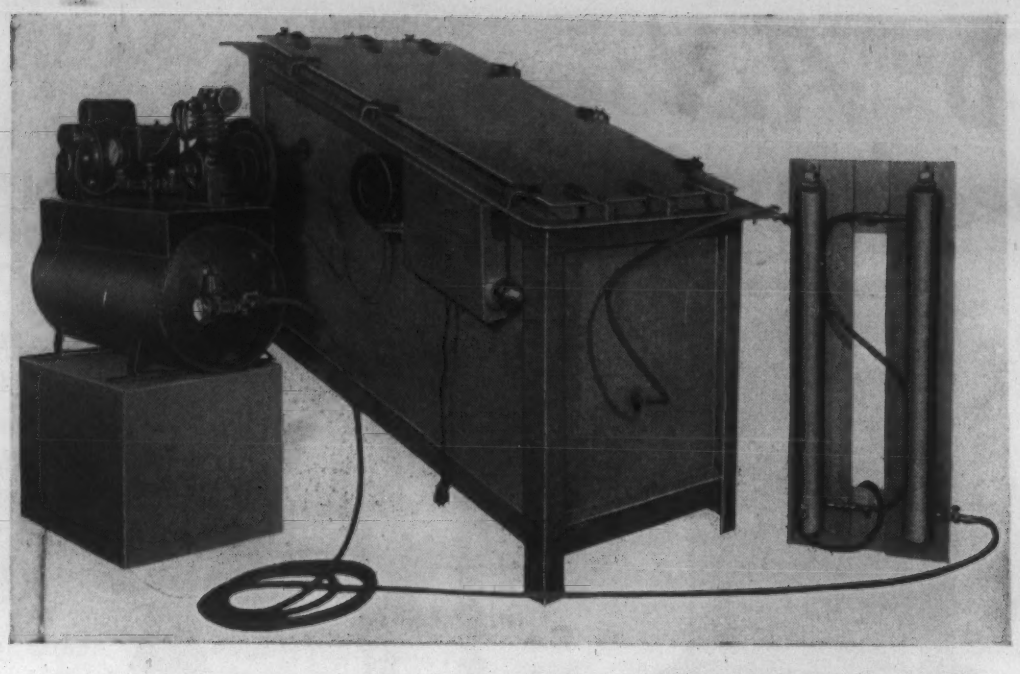

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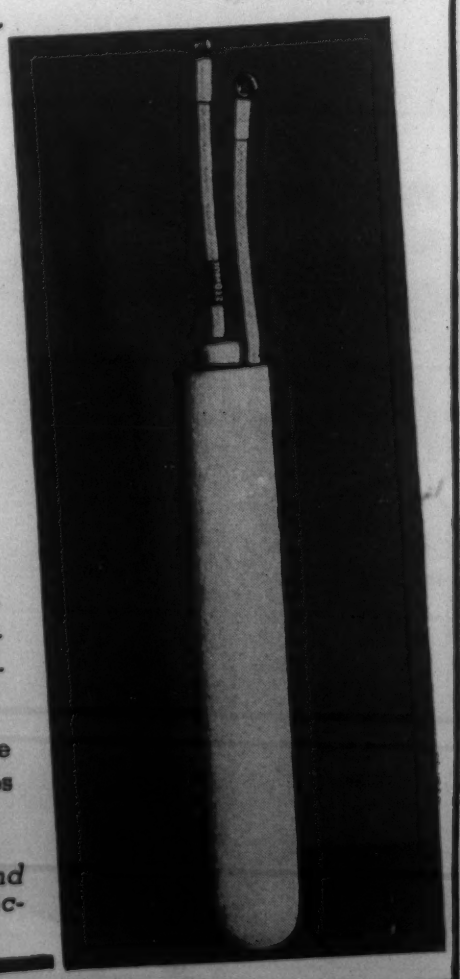

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gineering, Lowell Textile Institute, will deliver his presidential address. New officers for the ensuing year will also be introduced.

The Marburg Lecture

The annual Edgar Marburg Lecture is always an outstanding event. This year the 18th Lecture will be delivered Wednesday, June 30, at 4:30 p.m., by L. J. Markwardt, Chief of the Division of Timber Mechanics, U. S. Forest Products Laboratory, Madison, Wis. His subject will be, "Wood as an Engineering Material."

General arrangements for the Pittsburgh meeting are in the hands of the district committee, headed by A. R. Ellis, president of the Pittsburgh Testing Laboratory, with J. J. Shuman, inspecting engineer of the Jones & Laughlin Steel Corp., vice-chairman; and H. H. Ambrose, of the Gulf Research & Development Co., secretary.

It is expected that there will be a very large number of committee meetings, with Monday, June 28, set aside for such gatherings. A large number of the committees will also meet on Tuesday, June 29, without conflicting with the technical sessions which start that day. And throughout the week many of these will find hours when meetings can be held.

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Shortest of all is copper, and officials say this critical shortage will continue for the duration. Copper refineries are not operating at full capacity . . . when they should be running wide open! Who knows how long that one scarcity may delay the final big push?

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Remember . . . if the item you scrap still appears on your books, it can be deducted. Otherwise it cannot. This is a matter for your accountant or attorney to decide. Even if not deductible, don't hoard it. For used machinery especially there's a big and continuing demand. *Somebody needs it—badly!*

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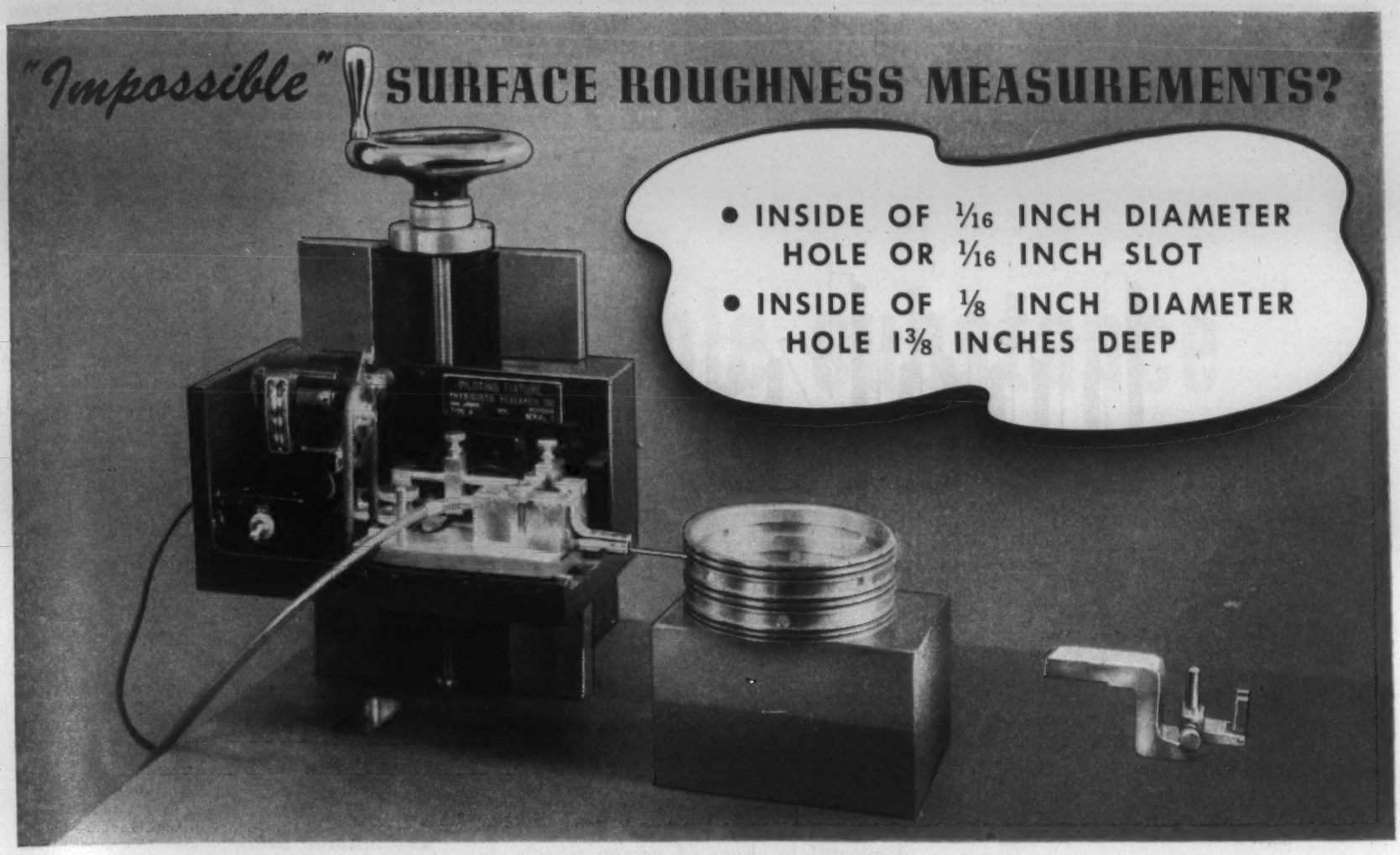

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TYPE "A" PILOTING FIXTURE – Supplied with an ample surface plate to provide a steady and rigid mounting for the parts to be measured. The stroke is adjustable from 1/32 inch to 1 inch. It may be used with type "K" Tracer as shown or with other Profilometer tracers used for mechanical tracing. With it, some of the most exact measuring jobs are easily performed.

TYPE "K" TRACER–(Shown mounted on Piloting Fixture) Specially designed for measuring in very narrow slots and holes. This tracer uses no piloting skids—the diamond being the only contact with the surface. For measuring on a wide range of curvatures and tapers, the diamond is self-adjusting after the initial setting has been made. Present models make possible measurements in 1/8 inch holes to a depth of 1 3/8 inches, and in 1/16 inch holes to a depth of 1/4 inch. It operates with any Profilometer.

Both the Piloting Fixture and Tracer are sufficiently flexible in their design that they can be modified to meet the requirements of specific jobs. Inquiries concerning these two Profilometer accessories should be accompanied by a description of the particular measuring problem so that all information which may be of interest to you can be sent without delay.

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books

FOR METALLURGICAL ENGINEERS

Problems In Production-Metallurgy

METALLURGICAL PROBLEMS—2ND EDITION. *By Allison Butts. Published by McGraw-Hill Book Co., Inc., New York, 1943. Fabrikoid, 6¼ x 9¼ in., 446 pages. Price $4.00.*

The present edition, appearing about ten years after Professor Butts' first rewriting of Richards' "Metallurgical Calculations," has been revised to accommodate changes in fundamental data and metallurgical practices, to clarify the original text for instruction purposes, and to offer new and more up-to-date problem material. Some 20 pages have been added, chiefly dealing with thermodynamic methods. Even though both the original and revisions were designed primarily as a college text, this book should prove as ubiquitous an aid to metallurgical engineers as was the original "Bible" of the genial Joseph W. to a preceding generation. Enough revised fundamental data are tabulated to supply most of the figures needed for off-hand calculations.

The examples and problems, from virtually every phase of metallurgical practice, are excellently chosen for illustrative and informative purposes. Were the times less febrile, we oldster metallurgists might well gain needed professional rejuvenation by taking time off to essay the interesting exercises offered. The author has taken such educative pains leading from the simplest considerations to the beginning of a modern viewpoint as may be required for a text of this sort. Even a metallurgist 25 years out of school should be able to work the problems with no more than deserved anguish.

That the author should feel it necessary to state in his preface ". . . knowledge of higher mathematics is still relatively unimportant in the use of the book . . ." is a sad comment on the professional education and status of the metallurgist, too frequently and too long dominated by deans of mining schools. It appears that students of the art that consumes a major part of the world's industrial fuel and energy still acquire as undergraduates only a casual smattering of the science of thermodynamics.

—C. G. MAIER

General Metallography

GENERAL METALLOGRAPHY. *By Ralph L. Dowdell, Henry S. Jerabek, Arthur C. Forsyth and Carrie H. Green. Published by John Wiley & Sons, Inc., New York, 1943. Cloth, 6¼ x 9¼ in., 292 pages. Price $3.25.*

This is an introductory textbook for engineers in general, though the space on etching technique, as well as the general treatment, indicates that the metallurgical engineer who will use metallographic technique has been most kept in mind. One would have expected Jominy hardenability testing and the N. E. steels to be featured.

A considerable amount of handbook data is included, some of it of general utility, some rather unrelated to the text. Four pages of tensile data on steels at low temperatures are included without reference to low temperature impact behavior. The useful binary constitution diagrams in Sachs-Van Horn are copied in the appendix.

In general, the material covered is that normal to the general subject, is clearly presented, and though sketchy, is suitable for its purpose, that of an introductory text. Other courses in materials of engineering would have to follow to give any brand of engineer a working grasp of the subject.

The book is evidently not designed for use by beginners who are working up the subject on their own, without benefit of instruction, and would not be outstanding for such use, but it is meant for classroom use, and for this seems adequate.

—H. W. GILLETT

Four-Language Dictionary

DICTIONARY OF SCIENCE AND TECHNOLOGY IN ENGLISH-FRENCH-GERMAN-SPANISH. *By Maxim Newmark. Published by the Philosophical Library, New York, 1943. Cloth, 6¼ x 9¼ in., 386 pages. Price $6.00.*

This dictionary will prove of considerable value to many technical, scientific and other readers. It is stated to be the outgrowth of some 10 yrs. of experience in teaching the reading and translation of scientific and technical material in foreign languages to the students of a polytechnical institution.

The result is the present dictionary of French, German and Spanish equivalents, synonyms and definitions of a basic list of some 10,000 English terms currently used in the polytechnical and scientific fields. In these four languages it contains approximately 45,000 terms with the total, including cross-references, close to 50,000. Two-way use of any of these languages with the English is possible because each entry is numbered and there are separate indices of French, German and Spanish terms, correspondingly numbered. The sole exception is compound terms.

The dictionary is adapted for foreign language reading in science and technology and, as its author hopes, it will provide a valuable reference work for technical and engineering libraries and for many research workers in the fields of chemistry, physics and engineering.

A feature that is emphasized is a more complete listing of current scientific, technical and aeronautical terms than is obtainable from any other bilingual or multilingual dictionary, such as bombsight, butadiene rubber, radio beam, paratroops, etc.

—EDWIN F. CONE

Other New Books

NITRIDING FURNACES. *Collected and arranged by D. Landau. Published by The Nitralloy Corp., New York, 1943. Paper, 6 x 9 in., 99 pages. Free upon request.* Responding to a demand that has persisted for some time for a practical text dealing with nitriding furnaces, The Nitralloy Corp., has recently published an illustrated booklet. The contents are divided into four parts: Part I. Nitriding and Nitriding Furnaces. Part II. Ammonia and Its Handling. Part III. Determination of Furnace Size for Nitriding. Part IV. Instruments for measuring Ammonia Flow, etc. Many worthwhile important facts are included. Lists of nitriding agents and manufacturers of nitriding furnaces are included.

HARDNESS. *By D. Landau. Published by The Nitralloy Corp., New York, 1943. Paper, 6 x 9 in., 105 pages. Free upon request.* The subtitle of this booklet reads as follows: "A Critical Examination of Hardness, Dynamic Hardness, and an Attempt to Reduce Hardness to Dimensional Analysis." This statement explains rather fully the scope. The Nitralloy Corp. believes that a study of dynamic hardness will, once the principle is thoroughly understood, yield important advances in engineering. The leading instruments used for testing hardness are illustrated and fully discussed. A bibliography of 60 references is included.

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Manufacturers' Literature

YOURS FOR THE ASKING

1. Ferrous Metals

ALLOY STEELS

Steel Analysis Chart. American Steel & Wire Co. AISI, SAE and NE steels, their analyses and numbers, have been compiled in the form of a wall chart, very convenient for reference. (1-218)

Machinery Steel Selector. Horace T. Potts Co. This guide for the proper steel for a given duty describes the Elastuf group of steels in terms of ready-for-use physical properties, soft-pedalling chemical analysis. (1-215)

High Strength Steel. Alan Wood Steel Co. (1-1)
Low Alloy Steel. Bethlehem Steel Co. (1-117)
High Strength Steel. Inland Steel Co. (1-90)
Molybdenum Steels and Irons. Molybdenum Corp of America. (1-133)
Magnet Steels. Simonds Saw & Steel Co. (1-209)

CARBON STEELS

Warehouse Steel. Bernard Epps & Co. Special bulletin, No. 16-B, presents an inventory of sheets, plates and strip in their Detroit warehouse, as of April 5. Gage, size and weights are listed. (1-216)

Cold-Finished Steels. Bliss & Laughlin, Inc. (1-206)

HIGH SPEED STEELS

High Speed Steel. H. Boker & Co., Inc. This 4-page folder deals with "Twin Mo — the high speed steel of the future." It deals exclusively with chemical and physical properties, and lists its uses. Curves supplement the tabular data. (1-217)

STAINLESS STEELS

Special Steels. Allegheny Ludlum Steel Corp. (1-196)
Characteristics of Stainless Steels. Crucible Steel Co. of America. (1-172)
Stainless Steel Identification Data. Peter A. Frasse & Co., Inc. (1-138)
Stainless Clad Steel. Ingersoll Steel & Disc Div., Borg Warner Corp. (1-104)
Stainless and Heat-Resisting Steels. Republic Steel Corp. (1-178)
Air-Hardening Die Steel. Jessop Steel Co. (1-205)

TOOL AND DIE STEELS

Proper Tool Steel. Carpenter Steel Co. This 4-page circular discusses the 315-page textbook "Tool Steel Simplified," by Frank R. Palmer. It tells how to select and heat treat the proper steel to make any kind of a tool. (1-219)

Tool Steel. Ziv Steel & Wire Co. Here is a "tool steel selector," a novelty in celluloid, whereby one slides a card out of an envelope, arranges the pointer correctly, then reads in the slot the characteristics of that steel. (1-214)

2. Non-Ferrous Metals

COPPER AND ITS ALLOYS

Extruded Bronze. Ampco Metal, Inc. Bulletin No. 109, a single page, tells of the company's new bronze extrusion mill for the production of aluminum bronzes and other copper-base alloys. An outline of how the bronze barstock is made is given. (2-219)

Condenser Tubes and Plates. American Brass Co. (2-108)
Oxygen-free Copper. American Metal Co., Ltd. (2-145)
Bronze Bar Stock List. Johnson Bronze Co. (2-175)
Forgeable Tin-free Bearing Metal. Mueller Brass Co. (2-165)
Phosphor Bronze. Phosphor Bronze Smelting Co. (2-213)
Leaded Bronze. Sumet Corp. (2-209)

LIGHT METALS

Magnesium Alloys. American Magnesium Corp. More data sheets, dated Feb. 1, 1943, have been issued in loose-leaf form, consisting largely of straight reading matter, with an occasional table and diagram. (2-218)

Ingot Metal. Bohn Aluminum Co., Michigan Smelting & Refining Div. (2-204)
Magnesium Alloys. Dow Chemical Co. (2-104)
Aluminum and Its Alloys. Niagara Falls Smelting & Refining Corp. (2-205)
Aircraft Aluminum Alloys. Reynolds Metals Co. (2-195)

LOW-MELTING METALS

Lead and Tin Products. Alpha Metal & Rolling Mills, Inc. (2-169)
Babbitts. American Smelting & Refining Co., Federated Metals Div. (2-193)
Lead-Base Anti-Friction Alloy. Graphitized Alloys Corp. (2-183)
Babbitt Bearing Metals. Magnolia Metal Co. (2-191)
Lead. St. Joseph Lead Co. (2-188)

NOBLE METALS

Industrial Silver. American Platinum Works. (2-200)
Silver. Sherman & Co. (2-184)

SPECIAL METALS

Special Alloys. Driver-Harris Co. "D-H Alloy Craftsman," Vol. 3, No. 2, presents sidelights on the applications of the company's nickel, chromium, copper, iron and manganese alloys. (2-216)

Indium. Indium Corp. of America. "A Bibliography of Indium — 1941-1942 Supplement" is the title of a 36-page booklet, listing trade and technical publication articles and textbooks, and giving in a nutshell what that article has contributed to knowledge. (2-217)
Cemented Carbide. Callite Tungsten Corp. (2-212)
Hard-Facing Metals. Coast Metals, Inc. (2-211)
Resistance Alloys. Wilbur B. Driver Co. (2-167)
Rare Metals, Alloys and Ores. Foote Mineral Co. (2-19)

3. Engineering Design

ALLOY CASTINGS

Stainless Steel Castings. Atlas Foundry Co., Atlas Stainless Steel Castings Div. (3-266)
Heat Resisting Alloy. Chicago Steel Foundry Co. (3-19)
Stainless Castings. Cooper Alloy Foundry Co. (3-9)
Corrosive Handling Equipment. Duraloy Co. (3-183)
Iron Alloy Castings. Duriron Co., Inc. (3-231)
X-ray Tested Castings. Electro Alloys Co. (3-74)
Corrosion and Heat Resistant Castings. Michiana Products Corp. (3-91)
Cast Alloy Furnace Parts. Standard Alloy Co., Inc. (3-251)
Alloy Castings. Sterling Alloys, Inc. (3-261)

Metals and Alloys, 330 West 42nd St., New York, N. Y.

I should like a copy of each piece of Manufacturers' Literature listed

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CASTINGS—IRON, STEEL, NON-FERROUS, ETC.

Tool Shanks. Cooper-Bessemer Corp. A comprehensive description of "Victory" shanks in 12 pages is both useful and ornamental. The forepart tells why Meehanite metal is used for shank castings. A double-page spread of large-sized photos shows a wide variety of shanks. (3-311)

Heat Treated Aluminum Castings. Acme Pattern & Tool Co., Inc. (3-290)

Heat and Corrosion Resistant Castings. American Manganese Steel Div., American Brake Shoe & Foundry Co. (3-204)

Heavy-Duty Bronze Castings. Cramp Brass & Iron Foundries Div. (3-83)

Special Castings. Hamilton Foundry & Machine Co. (3-296)

High Strength Castings in Industry. Meehanite Research Inst. (3-94)

Non-Ferrous Castings. Metal & Alloy Specialties Co. (3-298)

Non-Ferrous Castings. Thomas Paulson & Son, Inc. (3-268)

Centrifugal Castings. Shenango-Penn Mold Co. (3-250)

Vanadium in Cast Steels. Vanadium Corp. of America. (3-196)

FORGINGS

Drop Forgings. Drop Forging Assoc. (3-237)

Special Forgings, Etc. Harrisburg Steel Corp. (3-292)

Drop, Hammer and Upset Forgings. Kropp Forge Co. (3-279)

Pressed and Forged Products. Lenape Hydraulic Pressing & Forging Co. (3-211)

METAL PARTS

Stamped, Drawn, Formed Parts. Goat Metal Stampings, Inc. A 4-page folder gives an outline of production facilities, arranged as follows: Type of product, typical parts produced, equipment, equipment capacity, and remarks. (3-313)

Miniature Precision Bearings. Miniature Precision Bearings. Radial and pivot-type bearings from 1/8 to 5/16 in. O.D., in both steel and non-magnetic beryllium, are described in Bulletin No. 43. A double spread tabulation gives dimensions and load ratings. (3-312)

Pressed Metal Stampings. American Pulley Co. (3-297)

Bronze Bushings. Atlas Brass Foundry, Inc. (3-305)

Fittings for Weld-Type Construction. Bonney Forge & Tool Works. (3-199)

Thermostatic Bi-Metal. W. M. Chace Co. (3-178)

Blind Rivets. Cherry Rivet Co. (3-294)

Permanent Magnets. Cinaudagraph Corp. (3-260)

Contact Metals. Fansteel Metallurgical Corp. (3-289)

Thermostat Metals. General Plate Div., Metals & Controls Corp. (3-181)

Electrical Contacts. Gibson Electric Co. (3-76)

Beryllium Copper Brush Springs. Instrument Specialties Co., Inc. (3-278)

Sheet Metal Parts. Kirk & Blum Manufacturing Co. (3-238)

Wear Resistant Precious Metal Parts. Permo Products Corp. (3-65)

Oil-less Bronze Bearings. R. W. Rhoades Metaline Co. (3-142)

NON-METALLICS

Heat-Resistant Glass. Corning Glass Works. Literature describes the versatility of glass, such as adaptation to custom finishing, close tolerances possible, resistance to corrosion, and ease of cleaning and joining to other materials, such as metals. (3-319)

Rubber Substitute. B. F. Goodrich Co. Catalog Section No. 9028 describes Koroseal, a plasticized polyvinyl chloride, for use as linings for tanks made of welded steel, wood or concrete, resistant to many strong corrosives. There are photos, tables and a list of typical installations now in service. (3-308)

Synthetic Rubber. United States Rubber Co. Five commercial types are set forth in a 40-page booklet, illustrated copiously with full-page pictures. Several graphic charts and diagrams of molecular arrangements clarify the text. (3-316)

Plastics. Bakelite Corp. (3-287)

Plastics for Industry. Catalin Corp. (3-232)

Insulating Material. Continental Diamond Fibre Co. (3-300)

Plastics in Product Design. Durez Plastics & Chemicals, Inc. (3-93)

Plastic Data Book. Formica Insulation Co. (3-210)

Corrosion-Resistant Equipment. Haveg Corp. (3-271)

Glass. Libbey Glass Co. (3-299)

Plastic Tubing and Fittings. Elmer E. Mills Corp. (3-247)

Plastics. Monsanto Chemical Co., Plastics Div. (3-277)

Ceramic Plastics. Westinghouse Electric & Mfg. Co. (3-236)

POWDER METALLURGY

(See also Sec. 2—Special Metals; Sec. 3—Metal Parts; and Sec. 8—Metal Powder Processing)

Porous Bronze Bearings. Bound Brook Oil-Less Bearing Co. Many parts, minute and fairly large, are illustrated in this 8-page booklet. One page lists numerous applications. Followers of powder metallurgy should be interested. (3-310)

Powder Metallurgy Products. Powder Metallurgy, Inc. (3-89)

TUBING

Special Tubing. Summerill Tubing Co. Bulletin No. 443 contains 12 pages of data on many specialties, including tapered and formed tubes. It has a guide chart on chemical composition of 25 metals entering the tubing. (3-309)

Welded Steel Tubing. (Price $1.00). Jackson Steel Tube Co., Inc. (3-282)

Special Tubing. Precitube Corp. (3-280)

History of Piping. Tube Turns, Inc. (3-303)

Pipe Protection Methods. Tubing Seal-Cap, Inc. (3-272)

OTHER METAL FORMS

Metal Stampings. Bossert Co., Inc. Design and production of all kinds of stampings done at the company's shop are described in a 16-page booklet, the story being told largely with photographs and captions. (3-318)

Screens Made by Electroplating. C. O. Jelliff Mfg. Corp. A 2-page reprint from the house organ of the International Nickel Co., Inc. describes a new process for the production of integral structure in meshes from 16 to 400, which require no weaving. (3-317)

Spinning Equipment. Milwaukee Metal Spinning Co. A 4-page folder cites the advantages of metal spinning and describes a difficult application that has very satisfactory results. (3-315)

Pre-Plated Metal. Apollo Metal Works. (3-307)

Steel Stampings. Worcester Pressed Steel Co. (3-273)

In this Manufacturers' Literature INDEX, new bulletins are given complete reviews, and previously described older bulletins are merely listed in their proper places.

4. Melting • Refining • Casting

ALLOYING AGENTS

Exothermic Alloying Agent. Chromium Mining & Smelting Corp., Ltd. (4-47)

Ferro Alloys, Deoxidizers, Etc. Electro Metallurgical Co. (4-49)

Recuperators for the Steel Industry. Fitch Recuperator Co. (4-121)

Lithium Copper. P. R. Mallory & Co., Inc. (4-55)
Titanium, an Alloying Agent. Titanium Alloy Manufacturing Co. (4-144)
Graphite Briquettes. U. S. Graphite Co. (4-112)

AUXILIARIES

Bond for Foundry Sand. American Colloid Co. A single page expounds Volclay bentonite and how it helps to prevent blows, scabs, porosity, rough finish, etc. (4-148)

Graphite. Joseph Dixon Crucible Co. A 13-page booklet, entitled, "New Graphite Know-How Package," explains numerous important applications of graphite and hints on using it with other ingredients. (4-152)

Aluminum Pattern Material. International Pulp Co. "Mouldene" for manufacture of aluminum master patterns and matchplates is described in two pages, being devoted chiefly to how to use in mixtures with other material. (4-150)
Metal Reclamation. Hardinge Co. (4-80)
Foundry Equipment. Modern Equipment Co. (4-146)
Mold and Core Wash. Refractory Mica Products, Inc. (4-107)
Graphite Crucibles. Ross-Tacony Crucible Co. (4-137)
Core Oils. Swan-Finch Oil Corp. (4-118)
Foundry Equipment. Tabor Manufacturing Co. (4-147)
Special Crucibles. Western Gold & Platinum Works. (4-122)

REFINING AGENTS

Materials for the Foundry. Foundry Services, Inc. (4-116)
Deoxidizers. Pure Chemical Co. (4-132)

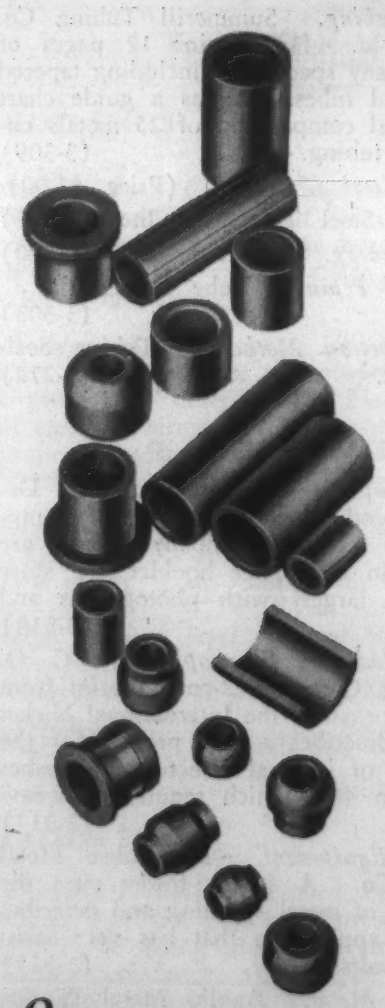
MELTING FURNACES AND PARTS

Crucible Furnaces. Stroman Furnace & Engineering Co. Melting furnaces for brass, bronze, aluminum, magnesium and other non-ferrous metals are dealt with in a 4-page folder, highly illustrated. (4-149)
Side Blow Converters. Whiting Corp. A 4-page folder uses for a headline: "Research Brings Back the Converter." Among the topics are: Low installation cost, produces high-grade and low-sulphur steel, flexible in operation, easy to operate and continuous metal supply. (4-153)
Induction Furnaces for Aluminum Alloys. Ajax Engineering Corp. (4-95)
Furnaces for Aluminum. Ajax Metal Co. (4-145)
Electric Furnaces. American Bridge Co. (4-82)
Laboratory Crucible Furnace. Campbell-Hausfeld Co. (4-105)
Cutting Crucible Costs. Crucible Manufacturers' Assoc. (4-36)
Crucible for Non-Ferrous Melting. Electro Refractories & Alloys Corp. (4-96)
Melting Furnaces. Harvey Furnace Co. (4-133)
Die Casting Machines. Lester-Phoenix, Inc. (4-117)
Regenerative Furnace System. Morgan Construction Co. (4-72)

RAW MATERIALS

Production of Silvery Pig Iron. Jackson Iron & Steel Co. (4-91)

JOHNSON BRONZE Ledaloyl SELF LUBRICATING POWDER METALLURGY



The BEARING *that* LUBRICATES *itself*

Oil is the life blood of every motive unit. In order to gain smooth, quiet operation; long, satisfactory bearing life, we must have the right amount of oil . . . in the right place . . . at the right time.

Johnson LEDALOYL bronze bearings provide this type of performance. Evenly distributed over all surfaces of every LEDALOYL bearing are millions of tiny, evenly spaced pores. Each of these pores serve as miniature oil reservoirs. Heat, generated by the turning of the shaft, draws the oil from the pores into the bearing area. Thus, a thin, protecting film of lubricant separates the shaft from the bearing, reduces friction to a minimum and assures long, satisfactory life. When the shaft stops, the oil is absorbed by the bearing.

Johnson LEDALOYL Bearings will help you simplify your designing problems . . . cut your installation costs. Before you start on a new design, get the facts regarding LEDALOYL. A Johnson Engineer will gladly review your applications at your convenience. Why not call him in . . . TODAY?

Over 2000 Stock Sizes

. . . enable you to make a further saving in time and money. Write for our new catalogue.

JOHNSON BRONZE
SLEEVE BEARING HEADQUARTERS
769 S. MILL STREET NEW CASTLE, PA.

5. Heating • Heat Treatment

ATMOSPHERES AND GENERATORS

SO_2 in Magnesium Industry. Ansul Chemical Co. (5-379)
Ammonia Dissociator. Drever Co. (5-205)
Pure Carbon Monoxide. Girdler Corp., Gas Processes Div. (5-386)
Control of Furnace Atmosphere. C. I. Hayes, Inc. (5-33)

AUXILIARIES

High Temperature Fans. Mahr Mfg. Co. A 4-page folder, No. 1070, deals with recirculating fans for either high or low temperatures. The brief text is augmented by diagrams, photos and specification tables. (5-420)

Sub-Zero Chilling. Motor Products Corp., Deepfreeze Div. The Santocel Cascade —120 deg. F. Unit is described on one page, this being one of a series of bulletins on various freezing equipment. (5-425)

Carburizer Screening Machine. Thurner Engineering Co. A machine that cleans carburizing compounds efficiently, the Carco-cleaner, is described in a 2-page bulletin, a sectional view serving as illustration. (5-419)
Oil Coolers. Bell & Gossett Co. (5-229)
High Temperature Heating Elements. Carborundum Co., Globar Div. (5-122)
Specifications and Heat Treating Chart. Chicago Flexible Shaft Co. (5-264)
Pressed Steel Pots. Eclipse Fuel Engineering Co. (5-352)

Furnace Trays. Fahralloy Co. (5-407)
Cold Temperature Processing. Kold-Hold Mfg. Co. (5-406)
Heat Exchanger for Metallurgical Operations. Niagara Blower Co. (5-293)
Sub-Zero Chest. Revco, Inc. (5-350)
Wire Mesh Baskets. Rolock, Inc. (5-235)
Furnace Door Hoists. Fred J. Ryan Co. (5-333)
Infra-Red Lamps. Wabash Photolamp Corp. (5-404)
Quenching Oil Coolers. Whitlock Mfg. Co. (5-318)

BATHS AND COMPOUNDS

Balanced Carburizing Baths. American Cyanamid & Chemical Corp. (5-135)
Heat Treatment of Shells. E. F. Houghton & Co. (5-361)
Heat Treating Materials. Kali Mfg. Co. (5-384)
Salt Baths. Park Chemical Co. (5-199)

BLOWERS AND COMPRESSORS

Turbo Compressors. Spencer Turbine Co. (5-335)

BURNERS

Infra-Red Ray Burner. Carbomatic Corp. (5-398)
Industrial Oil Burners. Fisher Furnace Co. (5-179)
Gas Appliances. Johnson Gas Appliance Co. (5-286)

ELECTRICAL HARDENING AND HEATING

Electric Forging Heaters. American Car & Foundry Co. (5-23)
Induction Heating Data Sheets. Induction Heating Corp. (5-299)
High Frequency Heating. Lepel High Frequency Laboratories, Inc. (5-340)
Induction Heating Furnaces. Robinson Induction Co. (5-387)

FURNACES

Gas Equipment. Charles A. Hones, Inc. Industrial gas equipment and burners are dealt with in a 30-page pamphlet, showing soldering and bench furnaces, torches, oven furnaces, muffle furnaces, melting furnaces, etc., all highly illustrated, and with tables. (5-426)

Aluminum and Magnesium Furnaces. Lindberg Engineering Co. Bulletin No. 140, 8 pages, shows many applications for accurate heat treatment of the light metals and their alloys. It shows furnace types available, explains the zone control method for large loads, etc. (5-421)

Carburizing Furnaces. Surface Combustion Div., General Properties Co., Inc. Continuous-type gas furnaces are depicted in a 4-page folder. On the back are data and graphs, entitled, "Sidelights on Gas Carburizing." (5-423)

Tool Room Furnace. Harold E. Trent Co. A 3-page folder concisely presents details of this hardening, annealing and heat-treating bench type furnace. (5-424)

Carburizing Gears. Ajax Electric Co., Inc. (5-399)
Electric Pot Furnaces. American Electric Furnace Co. (5-97)
Furnaces and Furnace Equipment. Amsler-Morton Co., Inc. (5-256)
Blowerless Furnaces. Baker & Co., Inc. (5-168)
High-Speed Steel Furnace. Bennett Insured Steel Treating Co. (5-310)
Industrial Furnaces. Dempsey Industrial Furnace Co. (5-342)
Bright Annealing. Electric Furnace Co. (5-44)
Electric Heating Equipment. General Electric Co. (5-284)
Pot Furnaces. A. F. Holden Co. (5-409)
Heat Treating and Laboratory Furnaces. K. H. Huppert. (5-303)
Principles of New Atmosphere Furnaces. Lithium Corp. (5-336)
Annealing Machines. Morrison Engineering Corp. (5-372)
Car Hearth Furnaces. R-S Products Corp. (5-392)
Electric and Fuel Car-Type Furnaces. W. S. Rockwell Co. (5-298)
Gas-Fired Oven Furnaces. Rolnick Testing & Mfg. Co. (5-175)
Heat Treating Furnaces. Salem Engineering Co. (5-341)
Bright Annealing Metal Strip. Sargeant & Wilbur. (5-200)
Clean Hardening for High-Speed Tools. Sentry Co. (5-202)
Electric Salt Bath Furnaces. Upton Electric Furnace Div., Commerce Pattern Foundry & Machine Co. (5-295)
Induction Heating Units. Van Norman Machine Tool Co. (5-396)
Heat Treating Furnaces. Vulcan Corp. (5-243)
Bright Hardening Equipment. Westinghouse Electric & Mfg. Co. (5-157)

OVENS

Tempering and Drawing Furnaces. Despatch Oven Co. (5-239)

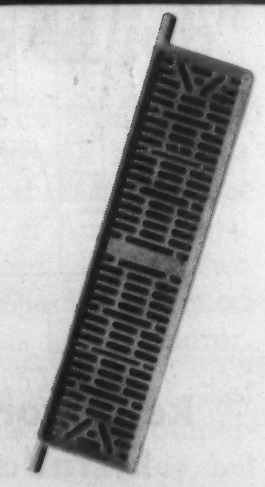
Official U. S. Navy Photograph

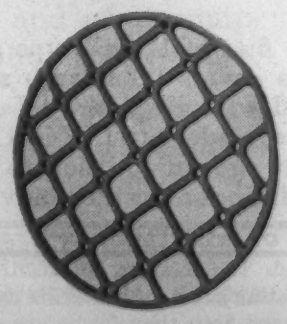
For the Engines of Our Naval Craft

Michiana Trays and Fixtures Used in Heat-Treating Vital Parts

● The speed and power of the U. S. PT Boats give these fighters their advantages on offense and defense . . . Reliability of their engines hinges on the dependable performance of every part, and MICHIANA well recognizes its responsibility in the production of the heat-resistant alloy furnace trays and fixtures used in the heat-treatment of vital parts of the famous Packard motors that power these craft.

MICHIANA PRODUCTS CORPORATION, Michigan City, Ind.





MICHIANA
Heat-Resistant and
Corrosion-Resistant
ALLOY CASTINGS

Infra-Red Equipment. Infra-Red Engineers, Inc. (5-401)
Constant Temperature Cabinets. Precision Scientific Co. (5-413)
Ovens for Finishing Processes. J. O. Ross Engineering Corp. (5-273)

PROCESSES

Surface Hardening Stainless Steel. Industrial Steels, Inc. This 6-page pamphlet is treated similarly to that of a feature article in a technical magazine, and describes a patent for hardening. (5-422)

The Nitriding Process. Nitralloy Corp. (5-278)

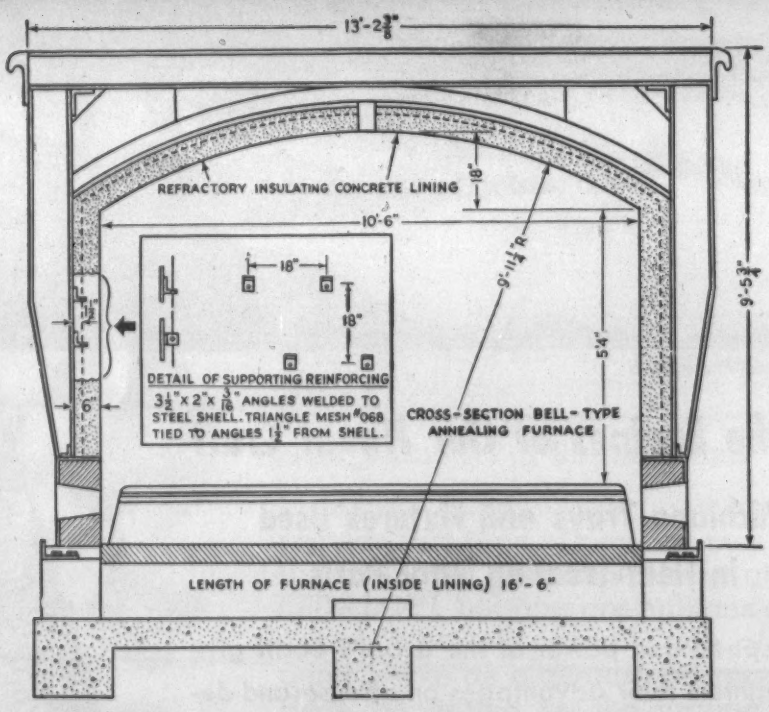
6. Refractories • Insulation

Linings for Ladles, Furnaces, Cupolas. Ironton Fire Brick Co. A single page describes Ironton "Caro-Line," a highly siliceous refractory material. (6-122)

Fire Brick. Walsh Refractories Corp. Products "for every refractory need" are described in an 8-page pamphlet, a feature of which is a center spread depicting many shapes of bricks. (6-123)

Furnace Refractories. Armor-Clad Co. (6-107)
Insulating Earth. Armstrong Cork Co. (6-121)
Heat Insulation. Baldwin-Hill Co. (6-99)
Dolomite for Electric Furnaces. Basic Refractories, Inc. (6-88)
Plastic Super-Cement. Botfield Refractories Co. (6-94)
Refractory Coating Material. Brickseal Refractory Co. (6-67)
Masonry Saw. Clipper Mfg. Co. (6-82)
Flux Resistant Refractory. Corhart Refractories Co. (6-95)
Coating for Firebrick. Federal Refractories Corp. (6-118)
Refractories Maintenance Coating. A. P. Green Firebrick Co. (6-70)
Insulating Brick. Illinois Clay Products Co. (6-100)
Asbestos and Magnesia Products. Keasbey & Mattison Co. (6-113)
High Temperature Bonding Mortar. Laclede-Christy Clay Products Co. (6-87)
Plastic Monolithic Firebrick. Mexico Refractories Co. (6-105)
Super-Refractories Products. Mullite Refractories Co. (6-75)
Insulating Refractory Concrete. Quigley Co., Inc. (6-18)
Super Refractories. Charles Taylor Sons Co. (6-16)
Silica Tubing and Rod. Thermal Syndicate, Ltd. (6-103)

JOINTLESS LINING SAVES HEAT IN ANNEALING FURNACES



Refractory *Insulating* Concrete Speeds Installation, Reduces Maintenance

The first of 12 bell-type annealing furnace covers in a large steel mill was lined with Refractory *Insulating* Concrete, made with LUMNITE, about two years ago. In addition to low first cost, the linings offer these advantages:

EASE OF INSTALLATION—The furnace cover is inverted. The mixture of LUMNITE, refractory-insulating grog and water, is cast in place. Arch is placed first; then forms are set and side and end walls are cast.

SAVINGS IN MAINTENANCE—The monolithic lining resists the strain and shock of lifting and dropping in place. There are no joints to loosen or small units to drop out.

SAVINGS IN OPERATION—Absence of joints increases efficiency of insulation. Low heat-storage and low conductivity save fuel in reaching and maintaining furnace temperature.

Refractory Concrete and Refractory *Insulating* Concrete, both made with LUMNITE, are meeting the wartime needs of many steel mills. We offer the help of our representatives in making the most efficient use of LUMNITE, which is now available only for service in essential war production. The Atlas Lumnite Cement Company (United States Steel Corporation Subsidiary), Chrysler Building, New York City.

LUMNITE FOR REFRACTORY CONCRETE

7. Welding

BRAZING AND SOLDERING

Silver Alloy Brazing. Handy & Harman. Information regarding the design of low temperature silver alloy brazed joints is presented in a 4-page folder, containing many illustrations, largely in miniature, and specification tables. (7-201)

Phos-Copper Brazing. Westinghouse Electric & Mfg. Co. Hints on good brazing and proper joint designs are given in a 12-page booklet, No. B-3201. Butt, scarf, shear and lap joints are considered, and diagrams show proper designs. (7-204)

Welding, Brazing Aluminum. Aluminum Co. of America. (7-192)
Low Temperature Welding. Eutectic Welding Alloys, Inc. (7-152)
Solder for Aluminum and Its Alloys. Metalloy Products Co. (7-125)
Soldering, Brazing Flux. Special Chemicals Corp. (7-67)

ELECTRIC ARC WELDING

Arc Welders. General Electric Co. Type WD direct-current, single-operator welders are discussed in a 12-page bulletin, No. GEA-1440J. It shows the operation of these engine- or motor-driven welders, and cutaway illustrations depict construction details. Six advantages are listed. (7-209)

Arc Welders. Hercules Electric & Mfg. Co. "The precision welder with the streamlined arc" is described in a 4-page folder, arranged artistically. (7-206)

Electrode Stubs. Lincoln Electric Co. "A Simple Plan for Electrode Stub Control" is a 5-page reprint of a technical article, designed to save cost of welding operations. (7-200)

Welding Equipment. American Agile Corp. (7-146)
Electrode Color Chart. Arcos Corp. (7-78)
A.c./d.c. Arc Welders. Dearborn Stove Co., Dearborn Welder Div. (7-165)
Hard-Facing Alloys. Dymonhard Corp. of America. (7-136)

Austenitic Stainless Steel Electrodes. Harnischfeger Corp. (7-110)

Arc Welding Check List. Hobart Brothers Co. (7-102)

Arc-Welding Electrodes. McKay Co. (7-164)

Corrosion- and Abrasion-Resistant Alloys. Wall-Colmonoy Corp. (7-123)

FLAME-PROCESSING

Blowpipes. American Gas Furnace Co. A 2-page folder discusses blowpipes, one of a long series of bulletins. Much data is compressed into a small space, including illustrations and tables. (7-210)

Oxyacetylene Welding and Cutting. Linde Air Products Co. (7-75)

GAS WELDING

Oxyacetylene Flame Adjustments. Air Reduction Co. A single page gives 5 color pictures that are more eloquent and enlightening than words. (7-211)

Acetylene Generators. Adler Mfg. Co. (7-189)

Bronze - Welding Alloys. Bridgeport Brass Co. (7-79)

Tool Steel Welding Rods. Welding Equipment Supply Co. (7-131)

RESISTANCE WELDING

Refrigerated Welding. Frostrode Products. Technical and descriptive bulletin, No. F-43, 4 pages, covers the complete "Frostrode" process of refrigerated welding, and packs a lot of information into a small space. (7-207)

Spot Welders. Eisler Engineering Co., Inc. (7-181)

Resistance Welder Control. General Electric Co. (7-150)

Seam Welders. Progressive Welder Co. (7-148)

Spot and Seam Welders. Sciaky Brothers. (7-163)

Electronic Welding Timer. Westinghouse Electric & Mfg. Co. (7-142)

SUPPLIES

Welding and Brazing Fluxes. Superior Flux Co. Four fluxes are described in new mailing pieces, of special interest to the aircraft industry. The text uses but few words to give specifications, prices and data on how to use. (7-202)

General Utility Torches. Insto-Gas Corp. (7-175)

Clean Welds. Midland Paint & Varnish Co. (7-191)

Welding Supplies. Special Welding Alloy Co., Inc. (7-199)

Metal Cutting and Welding Equipment. Victor Equipment Co. (7-139)

RIVETTING

Automatic Buckers. Aero Tool Co. This 6-page booklet, generous with illustrations, presents, with no unnecessary words, the principle and application of this tool, which women can operate easily on rivets. (7-203)

Explosive Rivets. E. I. duPont de Nemours & Co., Inc. A 6-page bulletin gives data on selecting the proper size and type of rivet, preparing holes, handling, storing and expanding the rivets, as well as the use and maintenance of the riveting iron. (7-205)

Please Use the Coupon on page 1313

8. Metal-Welding

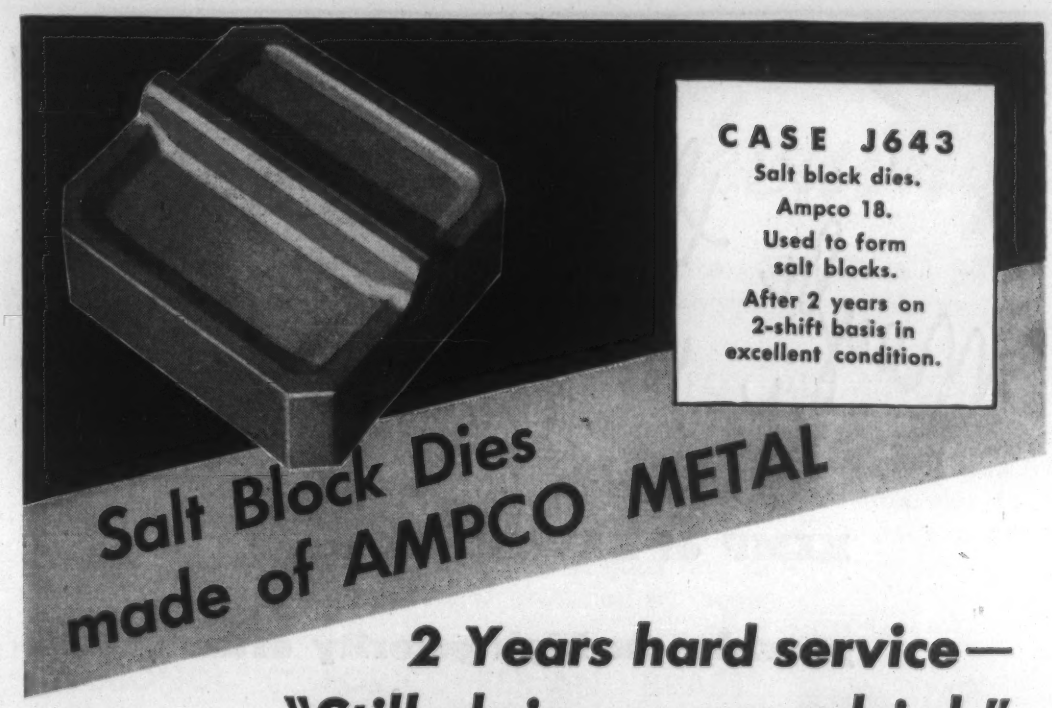
FORMING

Presses. E. W. Bliss Co. Straight side eccentric shaft presses are described in a 16-page catalog, with full page illustrations, specification tables and occasional text. (8-272)

Straighteners. McWilliams Mfg. Co., Inc. This 4-page pocket-size bulletin describes the Corey straightener with photographs and brief paragraphs. (8-278)

Die-Casting Machines. Reed-Prentice Corp. Full hydraulic die casting machines for zinc-, tin- or lead-base alloys are portrayed in a 4-page bulletin, consisting largely of photos, diagrams and specification tables. (8-273)

Extrusion Presses, etc. John Robertson Co., Inc. This 16-page pamphlet describes lead encasing machinery, high pressure hydraulic pumps and closed lead melting pots. The bulletin, Vol. 10, No. 4, is called "Robertson Reminders." (8-268)



2 Years hard service— "Still doing a good job"

The corrosive action of salt—its abrasive effect on forming dies — the tremendous pressures needed in forming salt blocks — all combine to make ordinary salt block dies short-lived. But when one prominent manufacturer tried dies of Ampco Metal Grade 18, replacement problems were solved. "After two years on a 2-shift basis the dies were still satisfactory — good for many months of hard service," reports this manufacturer.

This experience has been oft repeated. Ampco Metal, that sturdy alloy of the aluminum bronze class, steps in and outperforms ordinary bronzes — not only in salt block die service, but as parts for machine tools, aircraft, ordnance, and other equipment. Ampco Metal stands up against wear, fatigue, and abuse.

Investigate this amazing bronze which delivers performance that is a credit to your selection. Ask for "File 41 — Engineering Data Sheets." Write today.

AMPCO METAL, INC.

DEPARTMENT MA-6 MILWAUKEE, WISCONSIN

Self-Contained Hydraulic Presses. Baldwin-Southwark Div. (8-65)

Die Matrix Alloys. Cerro de Pasco Copper Corp. (8-106)

Assembling Presses. Denison Engineering Co. (8-120)

High Speed Presses. Di Machine Corp. (8-226)

Drawing Compounds. Glyco Products Co., Inc. (8-264)

Hydraulic Press. Hydraulic Press Mfg. Co. (8-140)

Metal Extrusion Press. Hydropress, Inc. (8-210)

Rotary Shears. Kling Brothers Engineering Works. (8-253)

Fabrication of Steel. L. O. Koven & Brother, Inc. (8-189)

Hydraulic Presses. Lake Erie Engineering Corp. (8-248)

Drawing Lubricants. Magnus Chemical Co. (8-93)

Turret Punch Presses. Wiedemann Machine Co. (8-213)

FORGING

Hydraulic Presses. A. B. Farquhar Co., Ltd. (8-146)

MACHINING

Broach Sharpening Machine. Colonial Broach Co. An 8-page, descriptive bulletin, No. CSI-43, describes the new universal machine with text and photographs. (8-275)

Abrasive Saws. A. P. de Sanno & Son, Inc. A 2-page display on a table type saw, No. 1, for dry cutting with radiac abrasive disks, is one of a series on the company's products. (8-277)

Tools. McKenna Metals Co. A new catalog, No. 43B, illustrates standard, nonstandard and special tools. It gives specific information on origin and qualities of Kennametal, with examples of machining operations performed. (8-265)

Cutting Oils. Cities Service Oil Co. (8-19)

Universal Machine Vise. Universal Vise & Tool Co. (8-181)

ROLLING

Turks Head. Standard Machinery Co. (8-192)

METAL POWDER PROCESSING

Presses for Powdered Metals. Kux Machine Co. (8-62)

Metal-Powder Mixers. Patterson Foundry & Machine Co. (8-114)

9. Cleaning • Finishing

Industrial Cleaning. Oakite Products, Inc. An enlarged, 12-page third edition, 8 pages, gives concise information in data sheet form on cleaning, descaling, derusting, paint stripping and related techniques in 54 essential plant maintenance jobs. (9-267)

Washing and Drying Machines. American Foundry Equipment Co. (9-232)

Airless Blast Cleaning. Dreisbach Engineering Co. (9-229)

Dust Collecting Equipment. Industrial Equipment Corp. (9-184)

Pre-Cleaning for Plating. Macdermid, Inc. (9-110)

Cleaning Compounds. Magnuson Products Corp. (9-254)

Heavy Duty Cleaning of Ferrous Metals. Pennsylvania Salt Manufacturing Co. (9-129)

Light Steel Cleaning. Philadelphia Quartz Co. (9-195)

Cleaning Equipment for Metals. N. Ransohoff, Inc. (9-230)

Abrasive Cleaning. Vapor Blast Manufacturing Co. (9-166)

CHEMICAL TREATMENTS

Blackening Aluminum. Enthone Co. Operating instructions for aluminum and its alloys appear in a 4-page bulletin describing Ebonol A, this pamphlet being one of a series. (9-278)

Oxide Coating on Metals. Alrose Chemical Co. (9-167)

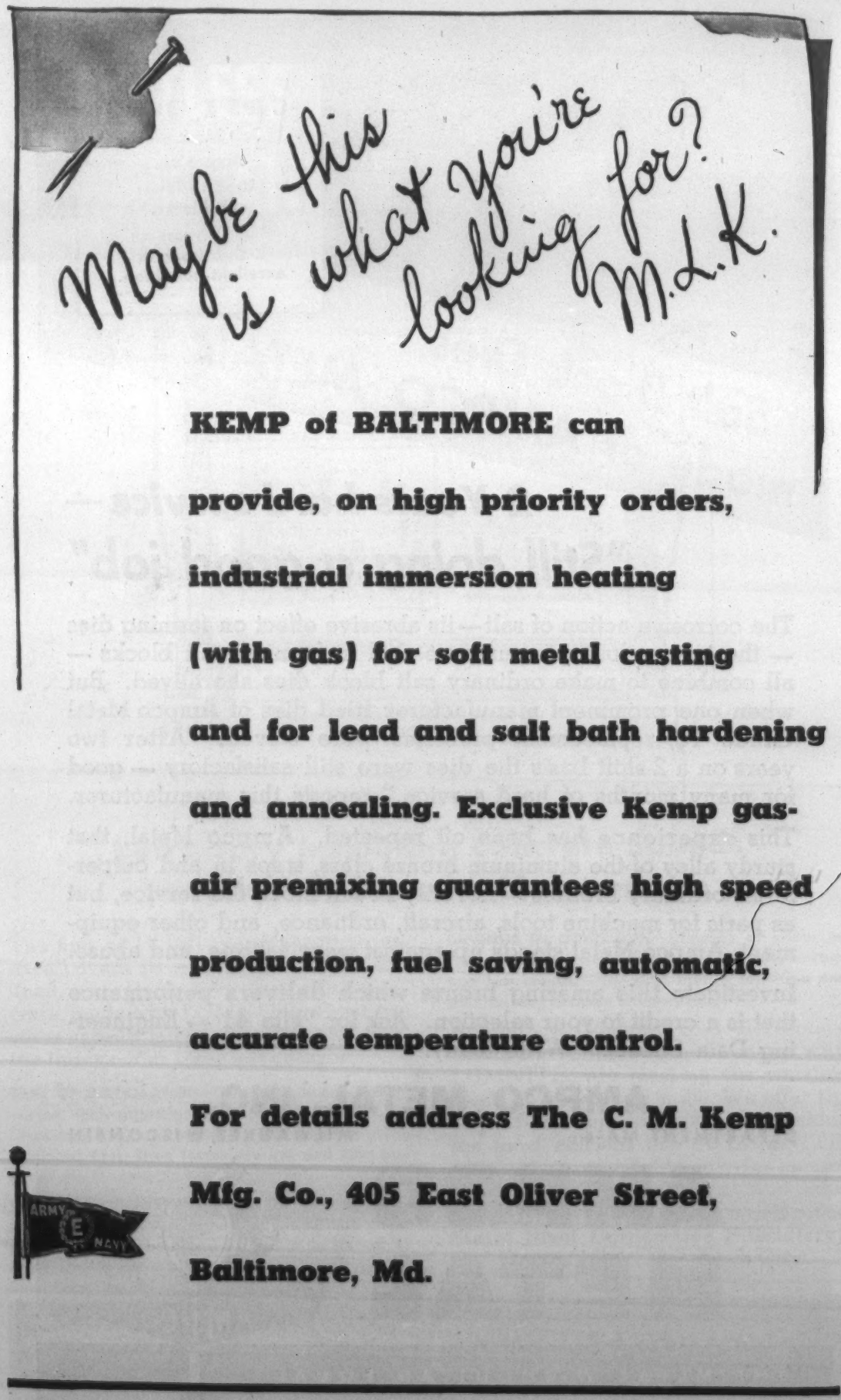
Black Finish for Steel. Du-Lite Chemical Corp. (9-244)

Finish for Steel. Heatbath Corp. (9-243)

Chemicals for Protecting and Coloring Metal Surfaces. Mitchell-Bradford Chemical Co. (9-152)

ELECTROPLATING

Rectifiers. W. Green Electric Co. "Planning Rectifier Installations" is the title of a 2-page reprint from a technical magazine. (9-277)



Zinc Plating. Turco Products, Inc. A 14-page technical report on bright zinc plating as a substitute for cadmium plating is designed for electro-platers and the metal trades generally. The new zinc cyanide baths, with their high throwing power, are described. (9-269)

Salvage by Hard Chromium Plating. United Chromium, Inc. (9-180)

METALLIC COATINGS (NON-ELECTROLYTIC)

Re-Galvanizing Welds. Galv-Weld, Inc. (9-223)

NON-METALLIC AND ORGANIC COATINGS

Paints. S. C. Johnson & Son, Inc. "War Formula Paints" is the title of a 10-page neat booklet containing a pocket on the inside rear cover in which are color cards and specification data. (9-270)

Lacquers. Egyptian Lacquer Mfg. Co. (9-183)

PICKLING

Pickling Inhibitor. American Chemical Paint Co. (9-208)

Corrosion Resistant Ceramics. Atlas Mineral Products Co. (9-72)

Ferric Sulphate and Cartridge Cases. Monsanto Chemical Co., Merrimac Div. (9-176)

10. Testing • Control

CONTROL INSTRUMENTS

Controllers. Bristol Co. An 8-page bulletin, No. A112, describes five types of convertible free-vane, air-operated controllers, and gives information on converting from one type to another. (10-381)

Heat Controls. Burling Instrument Co. Temperature and safety limit switches are described in a 4-page pamphlet for various industries, such as aircraft and aluminum manufacturing. (10-378)

Relays. Barber-Colman Co. (10-331)

Proportioning Control System. Brown Instrument Co. (10-209)

Flue Gas Analyzer. Charles Engelhard, Inc. (10-143)

Control Devices for Atmosphere Furnaces. Fischer & Porter Co. (10-373)

Thermocouples, Etc. Arklay S. Richards Co., Inc. (10-355)

HARDNESS TESTING

Hardness Testing Machines. Riehle Testing Machine Div., American Machine & Metals, Inc. This 20-page pamphlet describes the Vickers, a British machine. It abounds with photos, charts, diagrams and concise word description. (10-384)

Diamonds for Hardness Testers. Industrial Diamond Co. (10-286)

Portable Brinell Hardness Tester. Andrew King. (10-148)

INSPECTION DEVICES

Vernier Angle Gage. Engis Equipment Co. The clinometer gage, which employs new principles in precision angle measuring, is described in a 4-page folder, well illustrated. (10-375)

Fluorescent Inspection. Larrimore Sales Co. Visual inspection with fluorescent two-tube daylighting is set forth in a 2-page literature piece, giving general and specific information. (10-376)

Strain Gages. American Instrument Co. (10-133)

Surface Smoothness Tester. Brush Development Co. (10-192)

pH Meters. Gamma Instrument Co. (10-334)

Magnaflux Inspection. Magnaflux Corp. (10-248)

Surface-Roughness Tester. Physicists Research Co. (10-262)

Illuminated Magnifiers. E. W. Pike & Co. (10-345)

Gage Blocks. George Scherr Co., Inc. (10-351)

Abrasive Wear Tests. Taber Instrument Co. (10-233)

Filtration of Coolants. U. S. Hoffman Machinery Corp., Filtration Div. (10-370)

MECHANICAL TESTING

Strain Gage. Baldwin-Southwark Div. (10-314)

Dynamometers. W. C. Dillon & Co., Inc. (10-338)

Fatigue Testing Machines. Krouse Testing Machine Co. (10-201)

Please Use the Coupon on page 1313

War Blackening

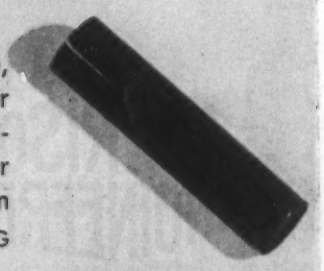
FOR ALUMINUM • COPPER • ZINC • STEEL

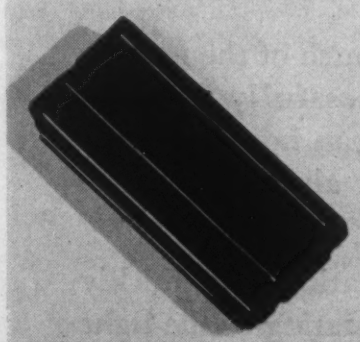
EBONOL "A" FOR ALUMINUM

A process for the direct blackening of aluminum and its alloys by simple immersion in two solutions. Jet black finishes on aluminum can be obtained in 7 minutes on large objects and small objects treated in bulk. The finish is hard and adherent and does not have to be protected by lacquer.

EBONOL "C" FOR COPPER AND BRASS*

Ebonol "C" is a process for simple, low-temperature, direct blackening of copper and almost all copper alloys. Both dull and shiny black finishes can be obtained. Finish is very adherent and has good wear resistance. Blackening done by immersion in from 3 to 10 minutes at 200 to 215°F. *PATENT PENDING





EBONOL "S" FOR STEEL AND IRON

Producers of war goods are finding EBONOL "S" to be the IDEAL BLACK. Only one bath is required, and the low temperature (280-290°F) means easier control, less fumes, less drag-out, and lower salt consumption. The finish is ferroferric oxide, which is hard, deep black, and adherent.

EBONOL "Z" FOR ZINC AND ZINC ALLOYS

A process for direct blackening of zinc and zinc alloys producing a hard, adherent, beautiful black in from 2 to 7 minutes. Now being widely used in place of plating and enameling, and as an undercoat for lacquers and enamels on zinc plate.

THE ENTHONE CO NEW HAVEN CONNECTICUT

REPRESENTATIVES IN PRINCIPAL CITIES

METALLOGRAPHIC EQUIPMENT

Metallurgical Polishing Equipment. Tracy C. Jarrett. (10-319)
Data on Electron Microscope. R. C. A. Manufacturing Co. (10-302)
Metallographic Polishing Powder. Conrad Wolff. (10-306)

RADIOGRAPHY

Protection From X-rays. Bar-Ray Products, Inc. A 4-page folder describes various lead doors, panels, partitions, etc. for protecting X-ray machine operators from injury. (10-374)
X-ray Films. Agfa Ansco. (10-315)
Industrial Radiography with Radium. Canadian Radium & Uranium Corp. (10-261)
X-ray Film. Eastman Kodak Co. (10-170)
Industrial X-ray Units. General Electric X-ray Corp. (10-324)
Industrial X-ray. Kelley-Koett Manufacturing Co., Inc. (10-185)
X-ray Diffraction Tubes. Machlett Laboratories. (10-300)
X-ray Illuminator. Picker X-ray Corp. (10-330)
X-ray Machine. Standard X-ray Co. (10-299)

SPECTROGRAPHY

Spectrographs. Jarrell-Ash Co. This 4-page treatise, straight text, is entitled, "A Stigmatic Grating Spectrograph for Industrial Laboratories," by Richard F. Jarrell. (10-380)

FORGING ALUMINUM

Calls for our specialized knowledge of furnaces

Morrison Engineered and Built Continuous Heat-Treating Furnace.

Because we have designed and built so much of the furnace equipment in use today in plants successfully forging, heat-treating and aging aluminum, we can honestly claim the title "Furnace Headquarters" when aluminum is the work and heating is the problem.

Pioneers in convection recirculating heating, we quickly recognized its many advantages for the heating of the light metals and their alloys. On these basic principles, we have designed furnaces that positively can not overheat the work—in sizes ranging from portable types to stationary large-production units.

If you are considering the production of *light metal* forgings—if you are hesitating because correct heating is a problem in your mind—Morrison will gladly help you. For quick action write, 'phone or wire.

MORRISON ENGINEERING CORPORATION
5005 EUCLID AVENUE . . CLEVELAND, OHIO
Associate Companies: MORRISON ENGINEERING OF CANADA, LTD. TORONTO, ONTARIO — CARRIER ENGINEERING CO., LTD. LONDON, ENGLAND

LABORATORY AIDS

Laboratory Aids. Burrell Technical Supply Co. (10-358)
Metallurgical Laboratory Equipment. Harry W. Dietert Co. (10-50)

11. General

Colloidal Graphite. Acheson Colloids Corp. A 4-page illustrated bulletin, No. 423-AF, presents "dag" as a high-temperature lubricant. It gives case study information on use for foundry oven conveyors, kiln cars, hot punches, piercing tools, forging dies, etc. (11-114)

Pumps and Hydraulic Equipment. Aldrich Pump Co. Many styles of pumps, with several industrial applications and auxiliary equipment, such as descaling nozzles, are described in a 16-page catalog, No. 100. (11-116)

Fire Extinguishing. American-La France-Foamite Corp. Two charts show operating characteristics of first aid fire extinguishers and wheeled engines and their suitability for Class A, B and C fires. Each fire demands its own fighting technique. (11-117)

Mechanical Copying. American Photocopy Equipment Co. A device for the copying of anything written, typed, printed, pictured or drawn, such as X-rays, is described in a 6-page pocket folder. (11-120)

Protecting Plastic. Ault & Wiborg Corp. A new transparent stripping lacquer for protecting metal, glass or ceramics from damage in process or storage is described in an artistic 6-page, plus inserts, bulletin. (11-115)

Filters. Cuno Engineering Corp. Filters for many applications and industries, such as aircraft, machine tools, steel, metalworking and finishes, are described in a 34-page booklet of above-average attractiveness. (11-121)

Preparing Engineering Reports. Alexander Hamilton Institute. Two very useful and stimulating pamphlets — "How to Prepare an Engineering Report" (68 pages) and "Forging Ahead in Business" (63 pages) — make profitable reading for engineers. (11-113)

Saving Air. Ingersoll-Rand Co. A series of posters has been devised, suitable for walls in plants, urging operators of air compressors and air-operated tools to conserve air, avoiding leaks and using it for purposes designed. (11-122)

Fire Extinguishers. Rockwood Sprinkler Co. This 8-page pamphlet describes "Waterfog," an extinguisher of fires, one of the applications being fires in dip or quench tanks. Illustrations are used profusely. (11-119)

Mounted Wheels for Portable Tools. Chicago Wheel & Manufacturing Co. (11-70)

Magnets and Magnetic Separators. Dings Magnetic Separator Co. (11-49)

Vacuum Pumps. Kinney Manufacturing Co. (11-112)

Mercury-Arc Rectifiers. General Electric Co. (11-85)

Acid-Proof Cement. Pennsylvania Salt Manufacturing Co. (11-71)

Water Softeners. Permutit Co. (11-75)

Centrifugal Blowers. Roots-Connersville Blower Corp. (11-102)

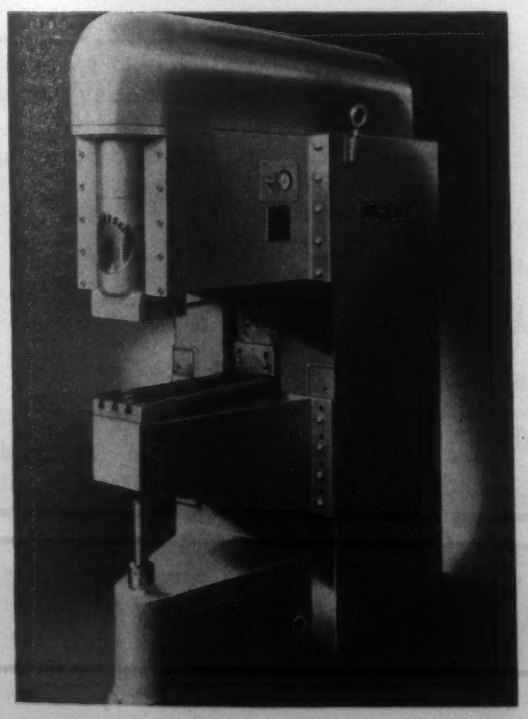
Tank Linings. U. S. Stoneware Co. (11-109)

METALLURGICAL ENGINEERING news

Equipment • Finishes • Materials • Methods • Processes • Products
Alloys • Applications • Designs • People • Plants • Societies

Complete Line of Resistance Welders

Standardized design, with maximum simplicity in operation and flexibility, characterize a line of press- or projection-type resistance welders of *Progressive Welder Co.*, E. Outer Drive, Detroit, in light, medium, heavy and extra-heavy duty types.



Each type is available in from 4 to 6 Kva. capacities and a variety of throat depths.

Each model is either air-operated or motor-driven, with hydraulic operation for extra-heavies. Each is readily converted to higher or lower capacities within its range. All have universal T-slot platens for mounting of fixture and dies. Knees are vertically adjustable for various throat openings. All have double cooling water manifolds in their bases, with outlets for up to 6 die-cooling circuits, platens also being water-cooled.

They are of unit construction, with a combination of castings and rigidly reinforced and braced welded plates. They are designed for 50/60 cycle supply and 220, 440 or 550 volts, as standard. The accompanying photograph is a light duty press welder.

● An improved welding glass, Alubro, which is blue in color, allows better vision than the usual green glass for aluminum and bronze welding, where sodium yellow glare is present. It was developed by *Willson Products, Inc.*, Reading, Pa. Standard green is still recommended for acetylene and electric arc welding.

Electronic Induction for Carbide Tools

Commercial availability of electronic induction equipment for routine brazing of carbide tools using any suitable brazing medium is announced by *Carboloy Co., Inc.*, 11155 E. 8 Mile Road, Detroit, Mich. Specialized engineering knowledge and national service facilities are provided cooperatively by the Carboloy and General Electric Companies.

The operator attaches the correct coil, sets the control dials on the oscillator to the proper current values, and pushes a button. A 15 kw. unit is for larger tools or multiple brazing of smaller tools; the 5 kw. unit is for smaller tools.

Among the advantages of induction brazing of carbide tools over other methods are: Greater convenience, speed, simplicity, accurate and automatic control, lower operating cost, less material needed, cleaner brazes, less maintenance, greater safety and more consistent brazes.

The accompanying photograph is of the last operation, which is to seat the tip firmly while the brazing material is still liquid.

Gage to Measure Angles and Inclinations

A versatile vernier angle gage, called the Clinometer, is announced by the *Engis Equipment Co.*, 310 So. Michigan Ave., Chicago. It employs new principles in precision angle measuring, and is designed for use wherever angles and inclinations have to be checked. It is used on various machine tools, such as lathes, drilling presses, shapers, gear hobbers, etc., and for test set-ups in the inspection room.

Precision measuring of angles and inclined surfaces is done by the Clinometer's new gravity mechanism. The action is a free-swinging drum graduated in 360 deg., supported by ball bearings. When applied to an inclined surface, the drum swings to a position that brings its center of gravity under its center line. The degrees of inclination are then read from a pointer above the drum. Minutes of the arc are indicated by a separate Vernier scale. Repeating accuracy has been tested to a precision of 7½ sec., reading accuracy to 1 min.

The Clinometer is not sensitive to shock, can be used in all temperatures, and is easily portable. In the general engineering field it serves better than a precision level, since it can measure any angle up to 360 deg. In the general manufacturing field it helps level the set-up of machine tools; checks straightness, twist of beds, and making of angle set-ups on drilling operations; and is used on shaper and planer jobs and on milling machines.

Dunking and Drying Basket

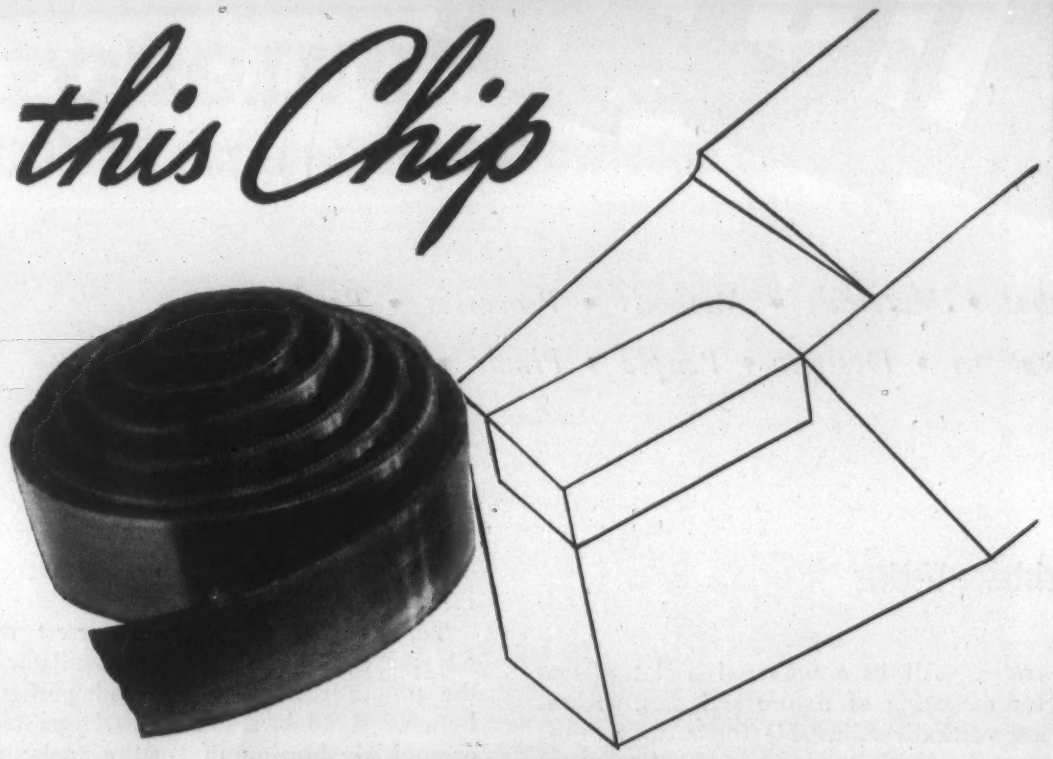
A dunking and drying basket made entirely from scrap metal is now included with a standard 5-gal. steel shipping pail with removable top containing the Carbon Met substitute for carbon tetrachioride.

Made by the *Curran Corp.*, Malden, Mass., all that is necessary is to place the part to be cleaned in the dunking basket when it bursts into volatile Carbon Met. On withdrawal, spring-like clips attach to the container's edge, allowing excess solvent to drain back.

Magnetic Chuck Grinding

A new Angle-Set-Magnet-Block for magnetic chuck grinding has been developed by the *Diamond Tool Co.*, 41st St. and Ellis Ave., Chicago. The purpose is accurate diamond dressing of surface grinders to insure the utmost in precision grinding for tool and die makers. Designed for wheels up to 8 in. in diam., larger diamonds can be set in it for larger wheels. The diamond can be kept sharpened by rotating only the top nib.

This dresser comprises three units, the "Magnet-Block," 2½ x 3 x 1 in., containing a 12° "Angle-Set" fitted with a Big-Hed nib containing a No. 10-CNX (1¼ carat common quality) diamond, and is equipped with two lock screws.



IS MORE PROOF
OF KENNAMETAL'S* STRENGTH

The chip illustrated above came off a 75mm. gun barrel being turned at 152 R.P.M. A grade KM, style No. 11T80 Kennametal steel-cutting carbide turning tool was used with a feed of .031" per revolution. Tool and chip are actual size.

Because of its greater strength, the Kennametal tool removed three times as much metal per minute as an ordinary carbide tool previously used and required grinding only once every 1½ hours.

When it is necessary to take heavy cuts and yet maintain high speed production, use Kennametal steel-cutting carbide tools. Write today for the new Kennametal Catalog 43B.

KENNAMETAL THE All American CARBIDE

*INVENTED AND MANUFACTURED IN U. S. A.

McKENNA METALS Co.
158 Lloyd Ave., Latrobe, Pa.
Foreign Sales: U. S. STEEL EXPORT CO., 30 Church St., New York (Exclusive of Canada and Great Britain)
Trade Mark Reg. U. S. Pat. Off.

THE 'AIR ARM' OF INDUSTRY

Applying Compressed Air for countless jobs is one of Ingersoll-Rand's major contributions for the industries of war and peace.

Armies of drill runners mining the vital metals, building the strategic roads and air fields, driving the tunnels for highways, railroads and water—all with rock drills powered by Compressed Air.

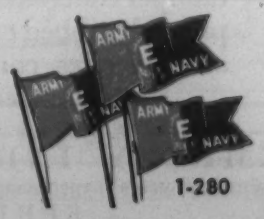
Thousands of men, women too, building planes, ships, tanks, autos, trucks, locomotives, bridges, machines, and process plants—with drills, grinders, riveting hammers, chippers, hoists—powered by Compressed Air.

Today's war production also emphasizes the use of Compressed Air for propelling torpedoes, scavenging guns, starting Diesels, for painting, for ship salvage, for blasting sirens, for inflation of tires, for blowing blast furnaces and cupolas to increase steel production....

Ingersoll-Rand has pioneered Compressed Air Systems since 1871, ever developing new and time-saving applications.

Ingersoll-Rand

11 Broadway, New York, N. Y.



COMPRESSORS • TURBO BLOWERS • ROCK DRILLS • AIR TOOLS • OIL AND GAS ENGINES • CONDENSERS • CENTRIFUGAL PUMPS

Method for Dies Saves Critical Steel

A 300 per cent faster method of manufacturing blank and pierce dies for aircraft and other industries is announced by *Algoma Products,* 3080 E. Outer Drive, Detroit. By the method that reduces cost 65 per cent, dies are produced from templates of the parts themselves, eliminating the need for special die design. It simplifies alterations due to engineering changes.

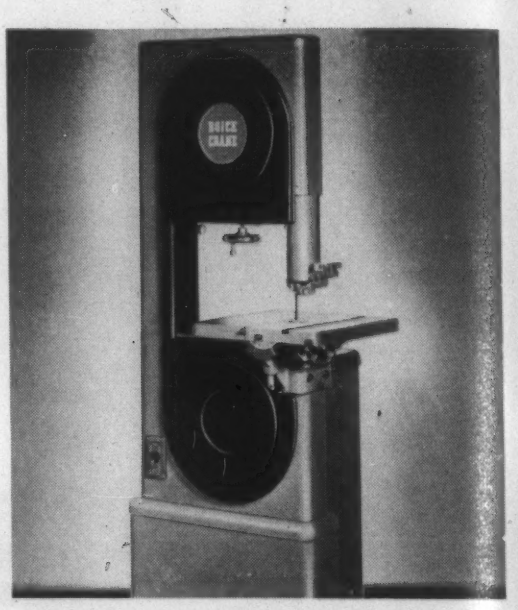
Instead of costly milling operations, the dies are contour-sawed from chrome "moly" steel, filed, sheared to size, hardened and welded to inexpensive back-up plates, thus conserving one-third of the critical alloy steel in conventional dies. Individually replaceable pierce punches of hard-drawn tool steel are pressed into the blank die and matching holes drilled in the blank punch for piercing holes in the part.

The Algoma template dies are self-stripping and self-ejecting. Rubber blocks, cemented to the back-up plates near the edges of the punches and in the blanking die, are compressed on the down stroke and, in returning to shape on the upstroke, strip the punches and eject the part from the die.

Powerful Vibrationless Band Saw

A powerful band saw for cutting metals, wood, plastic and paper is introduced by *Boice-Crane Co.,* 962 Central Ave., Toledo, Ohio. It cuts stock 8⅝ in. thick, handling work 27 in. in diam. An accurate blade tension scale is a feature. Operation is quiet and vibrationless.

The wheel guard must be closed to operate the machine. A telescoping guard holds by friction when the lock handle is released, and it will not drop while adjusting. Blades are ⅛ to ¾ in. thick, and are adjusted by a single knob control.



The table is rigidly supported on large trunnions and no portion can sag. It tilts 45° to the right and 10° to the left. There are eight speeds. Heavy-duty gears transmit up to 1 h.p. at lowest speed.

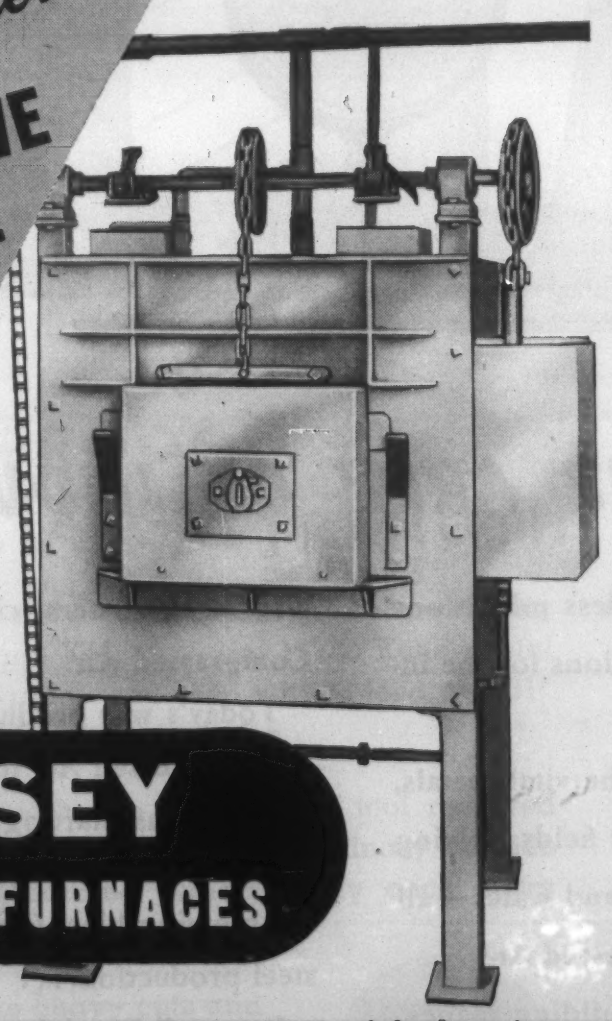
New Line of A.C. Arc Welders

A complete line of industrial a.c. arc welders has been added to its present line of P & H d.c. machines by *Harnischfeger Corp.,* 4400 W. National Ave., Milwaukee. They are being made in 7 heavy-duty and 4 intermittent duty models, able to handle production welding under continuous operation.

It features the Welding Service Range ratings, which show the actual minimum to maximum output of usable welding current. The complete range of ratings is 20-185 amps. to 200-1200 amps. Setting and control of current throughout complete ranges involve one simple, easy-to-operate adjustment. It is creep-proof.

Because of mechanical and electrical refinements, the a.c. models have shown gains in operating efficiency as high as 95 per cent, with much reduced maintenance cost.

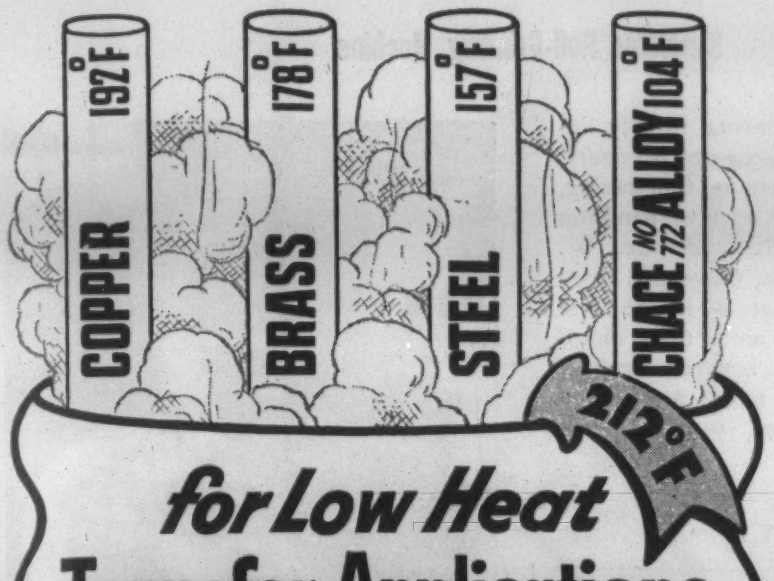
OIL OR GAS-FIRED
. . . Every One WITH Automatic Mixer FOR SINGLE VALVE CONTROL



DEMPSEY
SEMI-MUFFLE FURNACES

Not only the gas-fired models, but every DEMPSEY *oil-fired* semi-muffle furnace is equipped with modern fuel-air mixer to permit manual or automatic single valve control. This feature alone is worth your investigating, but in addition, DEMPSEY offers you such innovations as safety weight guard, silicon carbide hearth, fuel saving damper control, heavy insulation and the costlier, heavier construction of properly ribbed cast-iron front bolted to welded steel housing. 14 standardized sizes completely designed and available for prompt delivery .... shipped assembled with piping manifold. Other sizes built to order.

DEMPSEY INDUSTRIAL FURNACE CORPORATION
Combined 50 years' experience building Dempsey and Gilbert & Barker Furnaces for all heat treating needs
SPRINGFIELD • MASSACHUSETTS



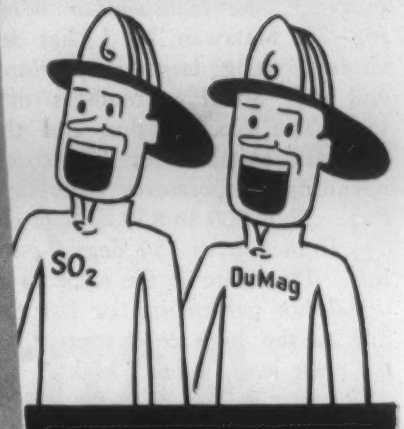
for Low Heat Transfer Applications use CHACE Manganese ALLOY No. 772

In the illustration above is shown a simple test that compares the heat transfer of Chace No. 772 Alloy with some common metals. One end of each rod was submerged in boiling water and temperatures read at exposed end with a room temperature of 80° F. Note that the increase of temperature over room temperature of the exposed end, of the copper rod, for example, was approximately five times that of Chace No. 772 Alloy rod. The drop in temperature in the copper rod was less than 10% as compared to a drop of over 50% in the Chace No. 772 Alloy rod.

The thermal conductivity constant (cal./sec./cm²/°C/cm) of 0.02 is far below the value of ordinary metals or alloys, and thus makes Chace No. 772 Alloy ideal for low heat transfer applications. Bulletin A-942, giving detailed information on the physical properties of Chace Manganese Alloy No. 772, sent on request.

W. M. CHACE CO.
Manufacturers of
Thermostatic Bimetals and Special Alloys
1615 BEARD AVE • DETROIT, MICH.

Overall Protection Against Magnesium Fires



ANSUL

SULPHUR DIOXIDE
for Fire Prevention
DUMAG POWDER
for Fire Protection

SULPHUR DIOXIDE is being used extensively and effectively to prevent oxidation, reaction and ignition of magnesium in pouring, casting and heat treating.

DUMAG COMPOUND effectively extinguishes magnesium fires. It is approved by Underwriters' Laboratories, Inc., and Factory Mutual Laboratories.

AVAILABLE IN ANY QUANTITY—Sulphur Dioxide in cylinders, ton drums, tank cars—DuMag in tubes, pails and barrels.

WRITE TODAY for Bulletin. Complete data supplied on economical and practical equipment for applying Sulphur Dioxide and DuMag.

LIQUID Sulphur Dioxide BY ANSUL duMag

"28 Years of Knowing How"

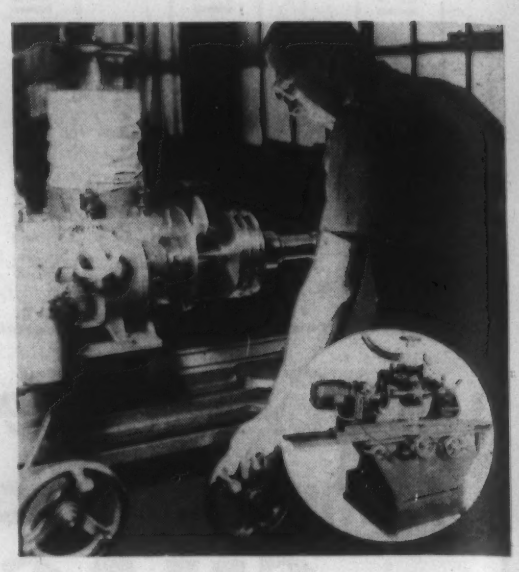
ANSUL CHEMICAL COMPANY
MARINETTE, WISCONSIN • EASTERN OFFICE, PAOLI, PENNSYLVANIA

● To conserve zinc and tin for coating purposes, the *Hanson-Van Winkle-Munning Co.*, Matawan, N. J., has devised substitutes, using large proportions of lead and only small percentages of zinc and tin. The No. 20 flux and the Fas-Tin flux are suitable for hot coating baths, operating temperatures determining which flux. Thus 800 to 850 deg. F. call for No. 20; from 500 to 750 deg. F., the Fas-Tin flux. Procedure is the same as in conventional hot galvanizing or hot tinning, but due to the high lead content, the operator must learn a few "kinks."

Simplified Roll-Grinding Machine

By eliminating adjustments usually included on a grinder that are not necessary, a simplified machine that is time-saving, lowers cost and promotes ease of handling has been turned out by the *Yoder Co.*, W. 55th St. & Walworth Ave., Cleveland.

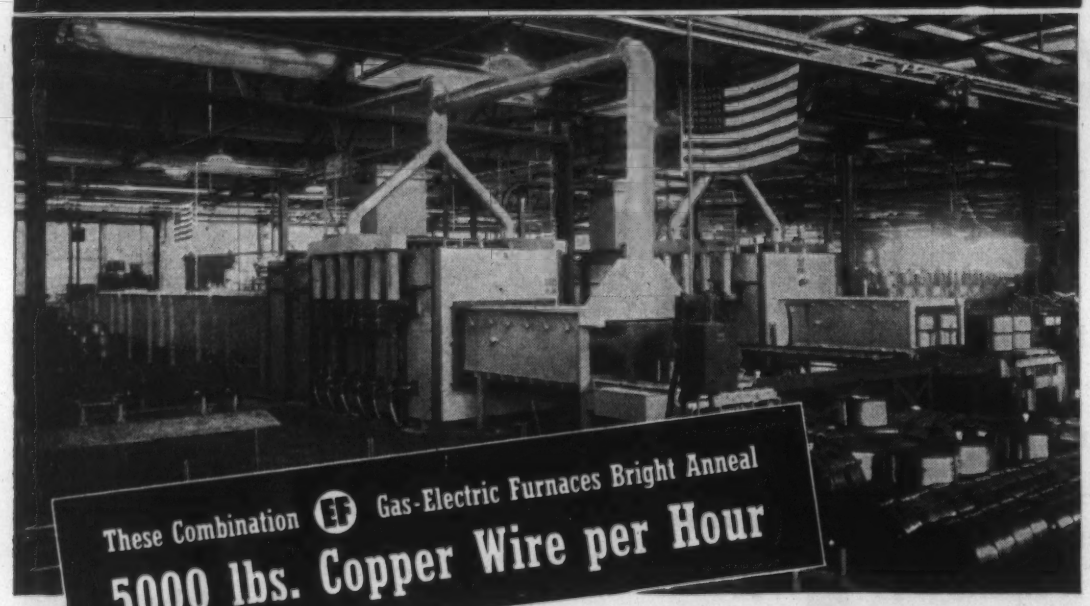
The maker claims that it is the first of its kind. Its features are: 16 in. diam. capacity, 20 in. length between centers, manually synchronized table and cross feeds, 2-speed table feed, 9-speed work



head drive, without belt or gear change, precision built high-speed spindle, dust protection, and centralized controls.

EF FURNACES

For Every Industrial Heat Treating Process



Equipped With

E F Gas-Fired Recuperative Type Radiant Tubes

Bright, uniformly annealed copper wire—at the rate of 2½ tons per hour—is produced continuously in the above combination gas-electric, controlled atmosphere furnace. These furnaces handle rod in coils up to 36" in diameter and wire on reels up to 21" in diameter. The material is carried through the furnaces on bulkhead type trays which provide an effective seal for the protective atmosphere used in the equipment. These trays eliminate the necessity of doors, lock chambers, or other sealing devices at either the charging or discharging ends of the furnaces.

The heating chambers are divided into two separately and automatically controlled zones. The first or charging zone of each furnace is heated by EF gas-fired recuperative type radiant tubes. The soaking zones are heated by heavy V-type cast alloy heating elements.

The heating elements in each zone are located above and below the charge and extend the entire width of the chambers, insuring absolute temperature uniformity throughout the charge.

The protective atmosphere is produced in an EF generator located between the furnaces.

Other recent outstanding production furnace installations include furnaces for bright annealing both ferrous and non-ferrous strip, wire, tubing and other products . . . furnaces for the production heat treatment of tank armor castings, cartridge cases, shell forgings, bomb and gun parts, machine gun cartridge clips, aircraft and aircraft engine parts, aluminum and magnesium castings, bolts, springs, and many other allied products.

We specialize in designing and building production furnaces.

The Electric Furnace Co., Salem, Ohio

Gas Fired, Oil Fired and Electric Furnaces---For Any Process, Product or Production

Furnace Atmosphere Indicator

A new furnace atmosphere indicator, based on the thermal conductivity method of analysis, has been placed on the market by the *Weaver Mfg. Co.*, Springfield, Ill. The ideal atmosphere for a given operation can be determined and subsequently reproduced for any similar operation by adjustment of the furnace's air-fuel ratio to give the same indicator reading.

The indicator is in continuous operation during the entire heating cycle, enabling the operator to detect any atmosphere change of consequence due to mariations in gas supply. Often the fuel saving over a short time offsets the instrument's cost.

The instrument employs the principle described by Palmer and Weaver in Technological Paper No. 249, published by the Bureau of Standards, U. S. Department of Commerce.

Pickling Machine for Shell Cases

A drum-type pickling machine, designed for shell cases and capable of handling 8,000 37-mm. cases per hr., has been developed by the *Howard Engineering & Mfg. Co.*, 1836 Freeman Ave., Cincinnati. Parts to be cleaned travel through the machine in a drum that varies in diameter between sections, each drum section running in its particular tank. Scale is removed from annealed parts by successive pickling, rinsing, neutralizing and rinsing.

Acid, rinse and neutralizing solutions are picked up by scoops on the side of the drum and dumped on the parts. The scoop method, as against pumps, saves acid. The machine is 35 ft. long, 8 ft. wide and 9 ft. high. Pickling and first rinse drums are of Monel, the tanks being lead-lined. It can be adapted to parts other than shell cases.

What's Behind the Trade Mark?

QUALITY

TRADE MARK

YOUNGSTOWN

SERVICE

Faith in the Future

The Youngstown Sheet and Tube Company was founded in November, 1900 by 47 local investors, with an authorized capitalization of $600,000. In December, 1901, this capitalization had been increased to $4,000,000 to provide for the expanded program decided upon by the men of vision who planned the future of this company.

In February, 1902, 14 months after the initial meeting of the shareholders of this company, the first product carrying the Youngstown trademark was produced. In this same year, these pioneers took the first step to assure complete integration . . . the first producing blast furnace was purchased... the first ore properties were acquired... and the first coal lands obtained. These early acquisitions all served as a nucleus around which was created the great industrial organization, which in later years served mankind in every corner of the globe where products of civilization were making life more complete.

We are doubly appreciative of the efforts of those who preceded us at Youngstown. These men of faith, courage, foresight and action have bequeathed to us those things with which we can make a definite contribution in helping to win freedom for the world today, and upon which we can help build an assured prosperity for the future.

Pipe and Tubular Products - Sheets
Plates - Conduit - Bars - Tin Plate
Rods - Wire - Nails - Tie Plates and
Spikes - Alloy and Yoloy Steels

The YOUNGSTOWN
SHEET AND TUBE COMPANY, Youngstown, Ohio
Manufacturers of
CARBON · ALLOY AND YOLOY STEELS

Bench-Type Tool Room Furnace

A new tool room furnace for hardening, annealing and heat treating has been brought out by *Harold E. Trent Co.*, Leverington Ave. & Wilde St., Manayunk, Philadelphia. It is heated electrically, and will operate as high as 1850 deg. F. continuously, with the following dimensions: width, 7½ in.; height, 5½ in. and depth, 14 in.

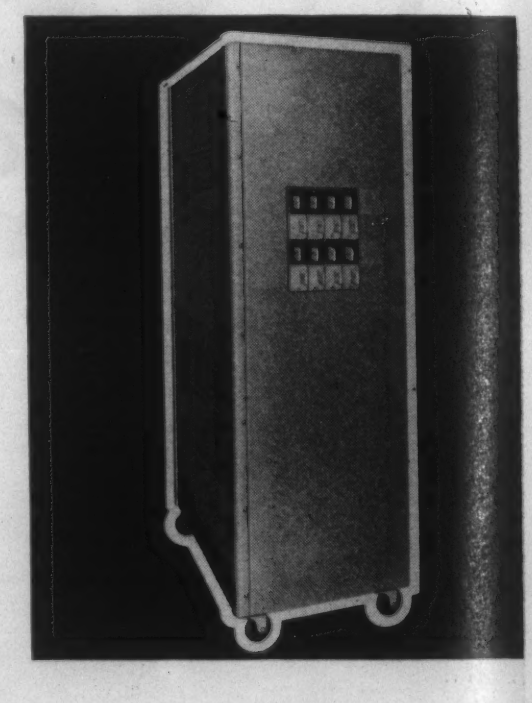
This MLR-4 bench-type furnace is built similar to the large Trent type-H box furnace. Heating elements are the "folded and formed" nickel-chromium ribbon units. The outer casing is of reinforced steel and lined with different layers of insulation. The welded steel door is brick-lined and over-laps the door opening; when open, it can be used as a loading table. The furnace can be operated either manually or automatically.

● A safety goggle to protect the eyes of women workers on the industrial war front has been introduced by *American Optical Co.*, Southbridge, Mass. Called Ful-Vue, it has 6.00 curve clear Super Armorplate lenses, and is designed to fit the smaller features of women, being made in 42-mm. eye size. Three bridge sizes are available: 19-, 21-, and 23-mm.

Multi-Plating Rectifiers

Incorporated in one cabinet are eight separate selenium rectifier sections, comprising the Model 86 multi-plater, produced by the *W. Green Electric Co., Inc.*, 130 Cedar St., New York. Each section has a capacity of 6 volts 500 amp. d.c.

These sections, with separate input and output terminals, may be interconnected in several hundred different combinations, to convert either 220 or 440 volt 3-phase a.c. to d.c. power for electro-plating, electro-cleaning, chromic or sulphuric acid anodizing, etc., in tanks, barrels or automatic machines.



Also available are Multi-Control units, individually engineered to adapt the Multi-Plater to present and postwar layouts.

ANACONDA

Electrolytic ZINC

SPECIAL HIGH GRADE

99.99+% pure

The electrolytic refining process, originally conceived for the treatment of complex lead-zinc ores, consistently produces zinc of the highest purity. 42282

ANACONDA

ANACONDA SALES COMPANY

25 Broadway, New York

Subsidiary of Anaconda Copper Mining Co.

● By maintaining custom-made atmospheres in armories, airports, flying schools and war plants, air conditioning apparatus, once built only for comfort, now has become a vital tool, stated L. W. Clifford, development engineer, *Westinghouse Electric & Mfg. Co.*, before a meeting of refrigerating engineers. A temperature change of even 1 deg. can impair the effectiveness of many devices. Among the chief users are gage testing, storage and calibration rooms.

Keep 'em "ON THE BALL"!

Get more out of instruments with this Quick-Check Maintenance System

Here's a way to put your instrument maintenance on a surer, simpler basis that will save production-robbing shutdowns for instrument servicing!

Foxboro's new Quick-Check System gives you a convenient 9"x11" card of A-B-C maintenance instructions for every major instrument in your plant . . . indicating, recording, or controlling . . . pyrometers, thermometers, gauges and meters. It makes *correct maintenance* practically fool-proof for the newest instrument man . . . saves time, ends oversights, keeps instruments always "on the ball"!

Any user of industrial instruments may obtain these useful Quick-Check Cards without charge. They outline correct maintenance for standard instruments of any make. Write for *your* set, specifying types of instruments you use. **The Foxboro Company, 178 Neponset Ave., Foxboro, Mass., U. S. A.** Branches in principal cities of United States and Canada.

Attached to installations or handily filed, Foxboro Quick-Check Cards give clear-cut directions for all essential steps in instrument maintenance.

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Instrumentation

SILVER

BRAZING ALLOYS:

"Readyflow"—56% Silver—works at 1165 deg.

B 201 —20% Silver—works at 1485 deg.

Also many other standard and special compositions.

ANODES:

Of all desired dimensions.

FLUXES:

For use with Silver Brazing Alloys.

Write for booklet "MA"

The American Platinum Works

N. J. R. R. AVE. AT OLIVER ST.

Newark, N.J.

EST. 1875

Damaged Strip Suitable for Mirrors

The highly-finished surface of steel strip going to a certain customer of *American Steel & Wire Co.*, Rockefeller Bldg., Cleveland, is so perfect that material having a slight surface blemish is still satisfactory for mirrors in vanity cases. A human hair passed through the rolls accidentally would bruise the surface of the roll and necessitate refinishing.

In this cold reducing process, the rolls, 18 in. in diam. and 32 in. wide, require special grinding and polishing, allowance being made for the minute bend that develops in the center upon application of the tremendous pressure required.

Series of Fans for High Temperatures

A new series of fans for high temperature work up to 1500 deg. F. is announced by *Mahr Mfg. Co.*, 1701 No. Second St., Minneapolis. These fans are standard equipment on Mahr furnaces and ovens, and are offered for replacements or initial installations on other furnaces and ovens. A feature is the 6-blade rotor and heavy-duty bearings, designed for severest operating conditions.

Rotor, shaft, bearings and mounting can be pulled out as a unit for inspection or servicing. The fans are easily assembled in 16 standard discharge positions without cutting, welding or rebuilding. There are 10 sizes from 800 to 40,000 c.f.m.

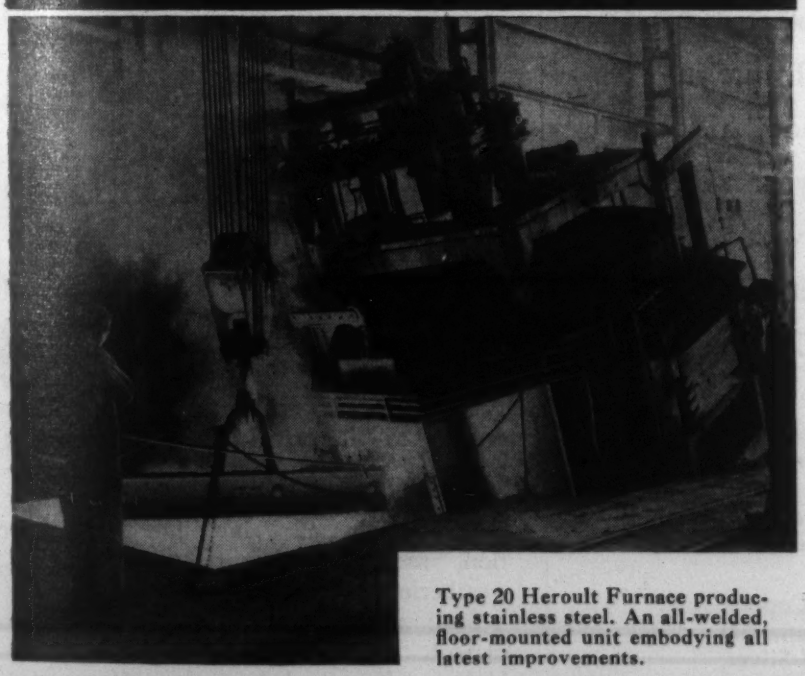
● Four new 35-mm. sound slide films describing the use of gage blocks are available from the *Savage Tool Co.*, Minneapolis. Subjects covered are: Theory of gage blocks, how they are used, how they are made, and use of gage instruments. The discovery of the constancy and uniformity of light waves, which gave man a permanent basic for units of length, is presented. The films will be loaned or sold.

Inspection Gage for Draw Punches

A final inspection gage, which requires only one-sixth the time formerly needed for checking draw punches, has been engineered by the *Salsbury Corp.*, Los Angeles. Known as Inspection Gage No. 508, it consists of a machined base, 14 in. long, on which is mounted necessary tool supports and three Koch test indicators.

The tool that this gage was designed to test is a precision ground draw punch, having three tapers. Checking the diameters on these tapers formerly required three separate micrometer readings by a trained inspector. They are now done simultaneously by a woman, by laying the tool on the gage and checking all at once.

It can be adapted readily to other tools. It is not for sale, but other manufacturers are welcome to its basic idea. The entire unit cost Salsbury less than $70.



Type 20 Heroult Furnace producing stainless steel. An all-welded, floor-mounted unit embodying all latest improvements.

PARTICULARLY designed and equipped for high-quality melting and refining of ferrous materials by either basic or acid process—including alloy, tool and forging steels, iron and steel castings. Any capacity from ½ ton to 100 tons; removable roof, chute, machine or hand charging.

AMERICAN BRIDGE COMPANY

General Offices: Pittsburgh, Pa.
Offices in the larger cities

Columbia Steel Company, San Francisco, *Pacific Coast Distributors*
United States Steel Export Company, New York

UNITED STATES STEEL

FLEXIBLE in Range . . . RIGID in Quality!

★ WILCO THERMOMETALS (thermostatic bimetals) have the *flexibility* to meet any temperature control or electrical resistance requirement—and the *quality* to maintain a tradition of excellence, which has continued unbroken for more than a quarter of a century.

★ Now functioning separately, now operating in conjunction with WILCO Electrical Contacts, WILCO THERMOMETALS are helping America win the war of the air, the sea and the land—helping through their matchless performance in Oil Temperature control, compensation in voltage regulators, and dependable action in many precision instruments.

★ Moreover, WILCO Aeralloy Electrical Contact Points are setting HIGH standards of service in aircraft MAGNETOS. Other WILCO Electrical Contacts are in tank, gun and ship applications—other WILCO THERMOMETALS in various instruments for the Army and Navy.

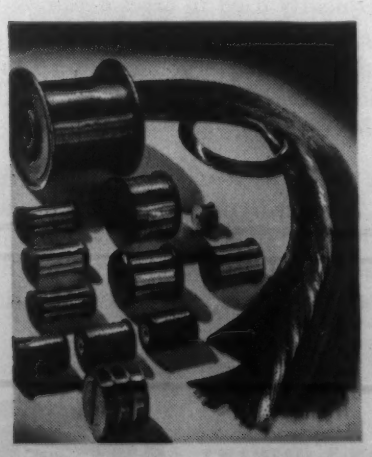
★ A SINGLE SOURCE OF SUPPLY. WILCO facilities permit manufacturing customers to secure both electrical contacts and thermostatic bimetal from a single source. This is important, for materials from these two groups are frequently used in conjunction, as parts in the same device. The most effective use of one necessitates a knowledge of the other. WILCO sales and engineering representatives are familiar with both Electrical Contact and THERMOMETAL application. Send us your problems for analysis.

WILCO PRODUCTS ARE: *Contacts*—Silver, Platinum, Tungsten, Alloys, Powder Metal. *Thermostatic Metal*—High and Low Temperature with Electrical Resistance from 24 to 530 ohms per sq. mil.-ft. *Precious Metal Collector Rings*—For rotating controls. *Jacketed Wire*—Silver on Steel, Copper, Invar, or other combinations requested.

THE H. A. WILSON COMPANY
105 Chestnut St., Newark, N. J.
Branches: Chicago ★ Detroit

WILCO

No, wire alone won't win the war. But we do believe that it is contributing its bit. That is why, we here at Callite are doing our very best to make that bit as important a contribution as we know how. Today C-T wire is serving in hundreds of wartime applications. Some we can't talk about, and other uses are commonplace. But the efficient performance of C-T wire in all of these applications, adds up to a wire "know-how" that might very well prove of service to you in solving your wire problems. Our metallurgists will be glad to cooperate with you. Callite Tungsten Corporation, 546 Thirty-ninth Street, Union City, New Jersey. Branch offices in Chicago and Cleveland.



Callite fine wires in sizes as small as .002" (smaller if required) for springs, control cables, instruments, wire cloth, brushes, bonding jumpers, etc. are available in:

Aluminum, Beryllium-Copper, Brass (all grades), Commercial Bronze, Everdur, Nickel-Silver, Phosphor-Bronze, Silver, Stainless Steel and Special Alloys.

REG. U.S. CALLITE TUNGSTEN CT PAT. OFF.

CALLITE WIRES

A FINE WIRE FOR EVERY NEED

Air Blast Barrel for Descaling

A newly-designed air blast barrel for descaling and cleaning has been developed by the *Dreisbach Engineering Corp.*, Yonkers, N. Y. Features of the new barrel are all-steel barrel and frame, adjustable bearings for roll shaft, and direct roller chain drive from 2 h.p. gear-motor mounted on the right-hand corner. The dust exhaust is also new, removing dust through the perforated plate at the rear end.

This machine is especially suitable for descaling, cleaning mat or frost finishing bronze, gray, hard and malleable iron, or steel castings, forgings, heat-treated springs and stamping in batch lots of one to four shop boxes. The barrel revolves one to two turns per minute, a slow speed suitable for very delicate and fragile articles.

Bimetal for Thermostatic Resistors

A new thermostatic bimetal, No. 6850, combining high electrical resistance with a high thermal deflection rate, has been introduced by *W. M. Chace Co.*, 1615 Beard Ave., Detroit. It is intended primarily for thermostatic resistors, which operate as a result of the heating effect of the current. Its applications range from flashers to motor overload protection, including particularly the newer circuit breaker designs.

Electrical resistivity is given as 850 ohms per circular mil foot, or 668 ohms per square mil foot, at room temperature. Deflection rate is practically uniform between 0 and 400 deg. F., and slightly lower above and below those temperatures. Operating characteristics remain constant at temperatures as low as —100 deg. F.

Precision Instrument for Measuring Gloss

The goniophotometer is an instrument for measuring the gloss of plane surfaces, such as paint finishes, enamels, lacquers, metals, wood, paper, plastics, glass, etc. It can measure the hiding power of deposited finishes, cleansing power of soaps and detergents, relative apparent reflectance of plane surfaces for obtaining Munsell value, index of refraction, resistance of surface to abrasion, weathering, wear, etc. and glare.

Such an instrument is the new Amin-co-Scott "glossmeter," which measures high, medium and low gloss (from zero to 100 per cent) of plane surfaces of materials over 2⅛ x 3 in. in size. Results are in terms of I.C.I. normal observer and I.C.I. illuminant C.

Illumination is adjustable from —30 deg. to plus 70 deg. from normal. The receptor is adjustable from plus 30 deg. to —70 deg. from normal. The instrument operates on 110-120 volts 60 cycles (controlled frequency) single-phase a.c.

It is made by the *American Instrument Co.*, Silver Spring, Md.

Why you get Quality Steel from Jessop

Users of Jessop Steels know the story of their quality and performance. But here is another—the story of a steel that is never sold.

In the yield from each melt there is a certain percentage of the surface metal which must be sacrificed in order that the remaining portion will be sound and usable. Jessop Quality Control, by taking numerous samples for tests and by such operations as grinding, chipping and cropping returns this steel for remelting. It is not for sale.

Only the highest quality electric furnace steel, subject to rigid inspection at each processing step is shipped from our mills. This assures highest performance in use. Information is available regarding Jessop Steels for your particular application.

JESSOP STEEL COMPANY

HEAD OFFICE AND WORKS

Washington . . . Penna.

HIGH SPEED, ALLOY, COMPOSITE AND CARBON TOOL STEELS
STAINLESS AND STAINLESS-CLAD STEELS

ESTABLISHED 1901

News of Men, Societies, Meetings and Companies

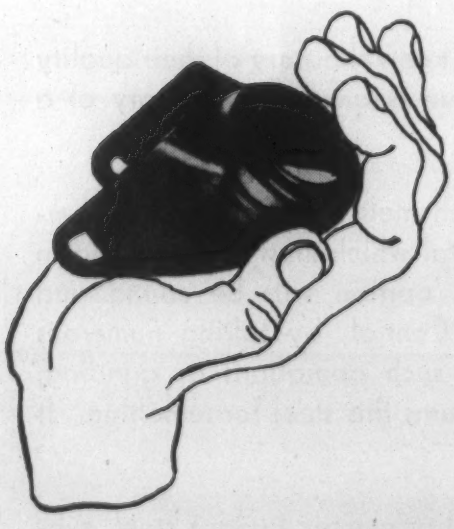
Plants and Slants

A group of leading British metallurgists made a tour of outstanding American steel plants early this spring, having been especially interested in plants that specialize in alloy steels.

In the accompanying photograph they are visiting the Brackenridge plant of the *Allegheny Ludlum Steel Corp.*, and with them are several metallurgists and officials of American steel companies, including their hosts.

Those in the group, as shown in the photograph, left to right, were: Dr. T. Swinden, of Samuel Fox, director of research of the United Steel Co., Ltd.; C. R. Wheeler, deputy controller of British Raw Materials mission; D. A. Oliver, of William Jessop's; Maj. E. W. Senior, director, Iron and Steel Div., British Raw Materials Mission; C. A. Scharschu, of Allegheny Ludlum; Dr. W. H. Hatfield, of Thomas Firth & John Brown, chairman, Technical Advisory Committee and Iron & Steel Technical Committee; G. W. Evans, Allegheny Ludlum; H. H. Burton, chief metallurgist, English Steel Corp.; C. B. Pollock, Allegheny Ludlum; Howard Biers, Electro Metallurgical Co. of Canada; V. B. Browne, Allegheny Ludlum; Dr. L. C. Hicks, Allegheny Ludlum; E. C. Bain, U. S. Steel Corp.; W. A. Givens, Allegheny Ludlum; F. B. Lonnsberry, Allegheny Ludlum; F. L. Toy, Carnegie-Illinois Steel Corp.; E. Barren, Carnegie-Illinois; George S. Rose, secretary, American Iron & Steel Institute.

Apparently most plants that receive an Army-Navy "E" commemorate the occasion in a conventional routine pattern. Occasionally the program committee has an inspiration and does something original. For instance, in the commemorative booklet of the *Firth-Sterling Steel Co.*, McKeesport, Pa., is a sketch on the history of the Navy "E." It was first instituted in 1906 for award within the fleet for excellence in gunnery, then for engineering and communications. Later it was extended for



Protect Metal Surfaces with Johnson's Rust Inhibiting Waxes

•Today, rust is a real enemy of much war and other equipment. To help guard against it, the makers of Johnson's Wax have developed special Rust Inhibiting Waxes for use on untreated metal surfaces and on black oxidized and phosphated surfaces. These new waxes also provide a desirable *dry* finish. They are easy to apply, either by dip or spray methods. Coverage per gallon is excellent; drying is rapid.

Johnson's Rust Inhibiting Waxes are non-toxic, non-flammable. They are ready to use; no mixing or dilution is necessary.

Free test sample and full information gladly sent on request. Write

S. C. Johnson & Son, Inc.

Industrial Wax Division, Dept. MA-63
Racine, Wisconsin
Canadian Address: Brantford, Ont.

★ BUY U. S. WAR BONDS AND STAMPS ★

...WHERE YOU NEED LIGHT COLOR AND GOOD CUTTING QUALITY...

ALTHOUGH it is scientifically recognized that "dark color" sulphurized cutting oils are superior to "light color" oils for the tougher metal cutting operations, there are some classes of machining for which transparent cutting fluids may be used with satisfactory performance. Stuart's "SUPER-KOOL", the leading example of "light color" transparent sulphurized cutting oil, offers many unique and exclusive advantages. Order a trial drum and be convinced.

use **Stuart's "SUPER-KOOL"** America's First Transparent Sulphurized Cutting Oil

For All Cutting Fluid Problems

D. A. STUART OIL CO. Chicago, U.S.A. • LIMITED • Est. 1865

Warehouses in Principal Metal Working Centers

THIS IS HOW TO *Prevent* CARBURIZATION or DECARBURIZATION

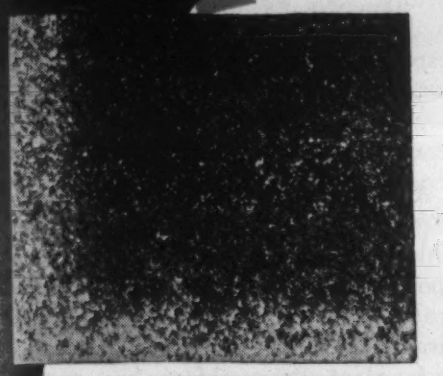


Fig. 1+2. Shows sample of carburized SAE 1015 Steel, treated on top and right hand edges to prevent carburization, as compared with untreated edges.

To prevent carburization or decarburization use Park's No-Carb liquid paint. It is a ready-to-use premixed product that requires no further additions or dilutions for application.

No-Carb is an excellent paint for use on finished molybdenum high-speed tools, or alloy steels, before and after fabrication, for prevention of decarburization (see photograph at right).

When applied to clean surfaces of low-carbon steels, No-Carb prevents carburization in selected areas (see photograph at left).

There is also a time saving advantage in using No-Carb, because on most jobs it can be applied by brushing, dipping or spraying directly from the can after stirring—it is not necessary to add to or dilute it.

For further information, prices, and delivery promises wire or write today.

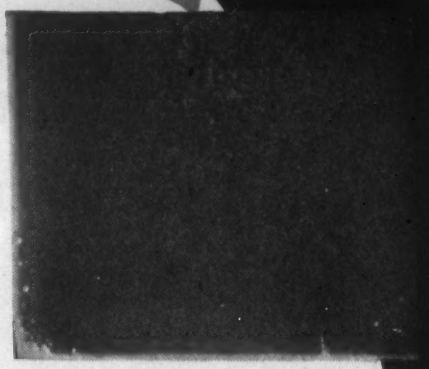


Fig. 2+2. Shows sample of molybdenum high-speed steel, hardened after treatment of top and right hand edges with No-Carb, while other two edges are unprotected.

★ ★ ★

Thirty-two years ago the Park Chemical Company began the manufacture of heat treating compounds. Today, Park's *Laboratory Controlled Products* are recognized for high quality by manufacturers who demand the best results in their heat treating departments. With the recent installation of one of the most modern heat treating and chemical laboratories in the country, Park has taken another step forward in giving its customers the advantage of better metallurgical analysis of their heat treat problems. This adherence to *Laboratory Controlled Products* has built for the Park Chemical Company an enviable reputation for selling products that are pre-tested for each particular job. This effects a saving to Park customers by eliminating trial and error methods on production lines.

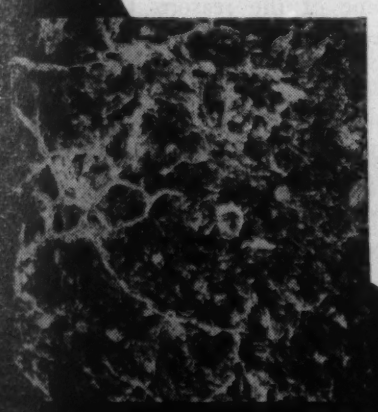


Fig. 3 + 50. Shows steel sample edge *unprotected* by No-Carb, where normal carburization has taken place.

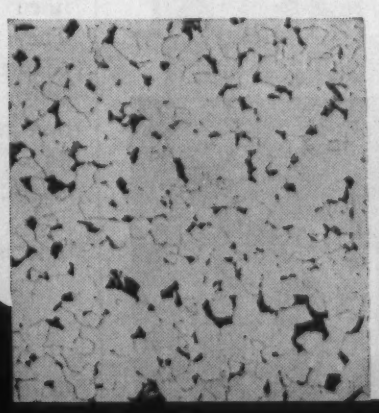


Fig. 4 + 50. Shows opposite edge of same sample, *protected* by No-Carb, where no carburization is evident.

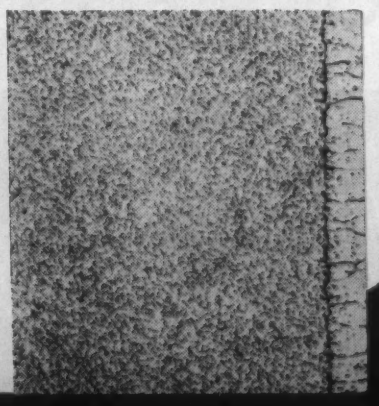


Fig. 5 + 50. Shows edge of hardened steel, *unprotected*, with decarburization evident on same.

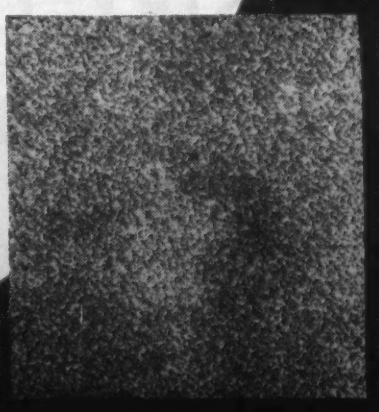


Fig. 6 + 50. Shows opposite edge of steel *protected* with No-Carb, where no decarburization is found, indicating excellent surface protection.

Park

PARK CHEMICAL CO.
DETROIT MICHIGAN

● Liquid and Solid Carburizers ☆ Cyanide, Neutral and High Speed Steel Salts ☆ Lead Pot Carbon ☆ Charcoal ☆ Coke ☆ No Carb. ☆ Carbon Preventer ☆ Quenching and Tempering Oils ☆ Drawing Salts ☆ Metal Cleaners ☆ Liquid Grain Cement

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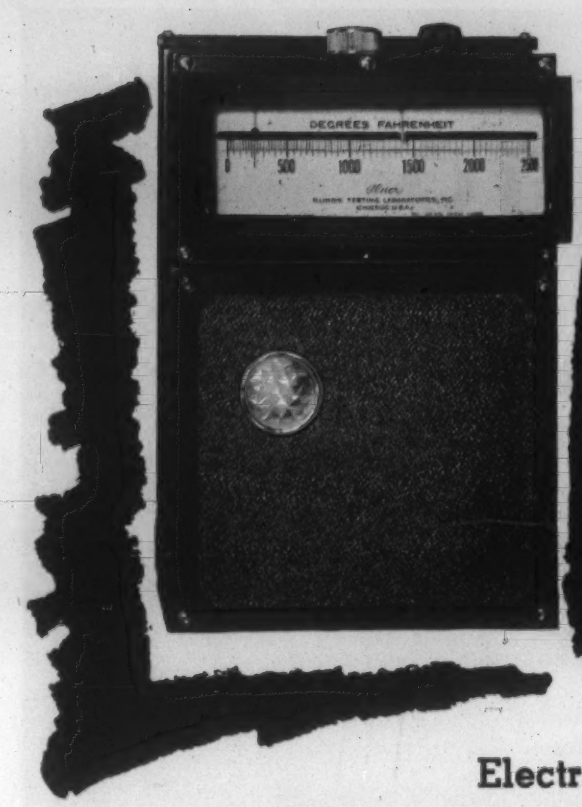


FOR BETTER CASTINGS Synchronize MOLD and MELT TEMPERATURES

with the Alnor Electronic Pyrometer Controller

The Alnor Controller offers a simplified, economical means of achieving the harmony of temperature between mold and melt which is essential for the production of faultless die castings.

Based on the principle of the electron tube, it provides full automatic control of fuel-flow or current without motors or moving mechanical parts . . . Sensitivity is such that variations in temperature equal to as little as .2% of the scale length induce control operation.

Write for full details and prices

Illinois Testing Laboratories Inc.
425 N. LaSalle St., Chicago, Illinois

HOW THE WROUGHT BRASS INDUSTRY CONSERVES METAL

No industry melting *commensurate tonnage of vital metal can quite match the brass mills for conservation and low melting losses. The savings of metal total millions of pounds; clearly the method they use is worth noting:**

Virtually all the brass mills in North America use the Ajax-Wyatt induction melting furnace, for it has the lowest metal losses in the field — less than 1% — with superior temperature control and unapproached economy of operation on high production schedules such as we have today.

Do you have your copy of "AJAX-METELECTRIC PROGRESS" — the magazine of induction melting, electric heat treating, non-ferrous ingot and alloys? Write to: AJAX ELECTRIC FURNACE CORP., 1108 Frankford Avenue, Philadelphia, Pa.

***HUNDREDS OF MILLIONS OF POUNDS ANNUALLY**

THE AJAX WYATT INDUCTION MELTING FURNACE

ASSOCIATE COMPANIES: AJAX METAL COMPANY, *Non-Ferrous Ingot Metals and Alloys for Foundry Use*
AJAX ELECTROTHERMIC CORPORATION, *Ajax-Northrup High Frequency Induction Furnaces*
AJAX ELECTRIC COMPANY, INC., *The Ajax-Hultgren Electric Salt Bath Furnace*
AJAX ENGINEERING CORPORATION, *Ajax-Tama-Wyatt Aluminum Melting Induction Furnaces*

excellence in producing ships, weapons and equipment for the Navy. Then came Pearl Harbor, when the scope of awards was broadened as we now know it, the Army having joined in with the idea.

Interesting, too, is the Army-Navy "E" booklet of the *Foxboro Co.*, Foxboro, Mass. After telling how instruments leave Foxboro for chemical plants, steel mills, magnesium plants and powder mills, etc., a bit of fine and inspiring writing follows: "True, we have no smoking freight yards filled with puffing switch engines, no fiery furnaces to light the midnight sky, no towering derricks. Our part is not outwardly spectacular, but it is the very essence of victory. So, we do it gladly, determined to do it ever better. For it is our proud responsibility to supply instruments—the instruments on which industry—and victory—depend."

A military atmosphere pervades the *Marmon-Herrington* plant at Indianapolis, which is turning out tanks, to impress upon workers that they are "soldiers of production." Each day bugles blow to indicate assembly, mess call, recall, etc. Each plant thoroughfare has appropriate signs such as "MacArthur Drive," "Casablanca Plaza" and "Wainright Street." Not only has this staging of emotional effects helped production, but also increased the purchase of war bonds.

Perhaps many are hazy as to what requisites are necessary for receiving the Army-Navy "E." When the *American Gear & Mfg. Co.*, Chicago, received the award, Col. Walter A. Furbershaw, chief of Intelligence Section, Sixth Service Command, who presented the "E" burgee, outlined some of the reasons for the award. They were: Ingenuity with which the plant adapted itself to the war's demands and assisted others to do the same, a production ten times normal capacity, high quality of gears produced, good records on accident, health and safety performance, condition of the plant, morale of workers and time needed to train new employees.

The *Lufkin Rule Co.*, Saginaw, Mich., attributed its attainment of the "E" to high achievement and exceptional performance, both as to quality and quantity production of tools indispensable to the war effort, to meeting or bettering of shipping schedules, maintenance of fair labor standards, and efficient management.

American Brake Shoe & Foundry Co. has shortened its name by dropping "and Foundry," thereby legalizing a name that customers had been using for years. * * * *Robins Conveying Belt Co.*, Passaic, N. J., has changed its name to *Robins Conveyors, Inc.*

Genesee Tool Co., Fenton, Mich., has issued a poster that depicts a bullet and a broken cutter with the words: "This bullet could stop a tank—this tool could produce enough equipment to stop 100

tanks." It emphasizes that "There is just so much tool steel available."

Algoma Products, Detroit, has been formed for the large-scale manufacture of template and fixture dies, for aircraft and similar industries. The company has taken over the former plant of the *Weltronic Corp.* at 3080 E. Outer Drive, as well as operating a second plant in the Detroit area.

The *Donner Hanna Coke Corp.*, Buffalo, has awarded to *Koppers Co.* of Pittsburgh construction of a battery of 15 Koppers-Becker type of by-product underjet ovens at Buffalo. This will be the third battery, others having been erected in 1918 and 1930.

After a record-shattering pig iron production for the Chicago district by *Carnegie-Illinois Steel Co.*, one of eleven blast furnaces at South Chicago is being relined completely for the first time in seven years, during which span it produced nearly 3,000,000 tons of iron.

Henry L. Crowley & Co., W. Orange, N. J., has extended its activities to powder metallurgy fabrication of intricate shapes and sizes.

The *Johnston & Jennings Co.*, 864 Addison Road, Cleveland, has purchased manufacturing and sales rights of Rusta-Restor, a cathodic process for preventing rusting of water tanks, piping and similar steel structures.

The name *Steacy-Schmidt Mfg. Co.* has been changed to *Hardinge Mfg. Co.*, which has customers in the mining, chemical and foundry industries.

The *Tool Engineering Service* has been formed at 505 N. 22nd St., Birmingham, dealing with standard and special machinery, tools, gages and industrial equipment, Harry D. Frueauff, Jr., is president.

Briefs on Associations, Promotions, Education

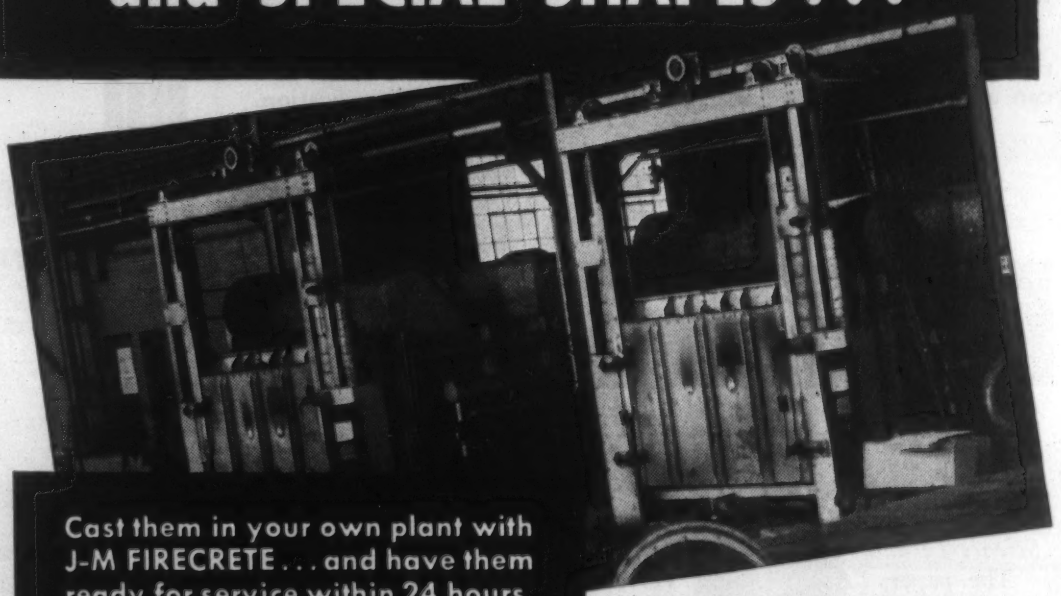
So sorry please!—but the bombing of Tokyo in April, 1942, was made possible in part by a Japanese slide rule with which was made thousands of calculations pertaining to Wright cyclone engines. The slide rule was one of many, absolutely precise, dropped on the American market to undersell American-made instruments. As a bit of whimsy such a rule, with a Rising Sun emblem on its inside surface, was given to Robert E. Johnson, chief field engineer, *Wright Aeronautical Corp.*, Paterson, N. J. Mr. Johnson compiled special data on Cyclone engine performance and fuel consumption at varying speeds, altitudes and loads.

The American Coordinating Committee on Corrosion met in the early spring at Pittsburgh to provide for revising its directory of technologists actively engaged in studies on corrosion and its prevention. The committee comprises delegates from 15 major technical societies, together with representatives from the principal industrial research institutes and the National Bureau of Standards. The directory lists 450 investigators. All interested parties who previously were not contacted by the committee are asked to write Dr. G. H. Young, 4400 Fifth Ave., Pittsburgh. At the spring meeting, Dr. R. B. Mears was elected committee chairman for 1943-44.

The iron foundry at the *Museum of Science and Industry*, the Lake and 57th St., Chicago, is producing war castings five days each week. The foundry was originally designed only for exhibit purposes. One of its first orders is for a small part weighing less than 2 lbs., to be used in making battleship parts. The foundry is still used as an educational exhibit, and students from the Washburn Trade School will gain experience there. It is under the supervision of Alex Dapogny, a veteran foundryman, and the general supervision of Dr. J. R. Van Pelt, the Museum's technical director.

The *Science-Technology group of the Special Libraries Assn., representing engineering, chemical, rubber, utilities and aeronautical libraries, both institutional and belonging to various firms, will meet at the Hotel Pennsylvania, New York, June 22-*

END DELAY on DOOR LININGS and SPECIAL SHAPES . . .



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Doors of these Swindell Dressler Annealing Furnaces lined with L. W. (Light Weight) Firecrete. L. W. Firecrete also used for doors of Amsler-Morton Billet Heating Furnaces, and H. T. (High Temperature) Firecrete for doors of Amsler-Morton Forge Furnaces.

Yes, Firecrete is a great time-saver in these days when speed is so vital. But Firecrete is also just about the best refractory you could possibly use from a performance standpoint. It has practically no drying or firing shrinkage and is highly resistant to spalling. It's used for furnace doors and linings, baffle tile, burner rings, pipe linings and special shapes. Four types available:

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For temperatures up to 3200° F.— J-M Chrome Castable. Designed particularly for use in forging and heat-treating furnace bottoms.

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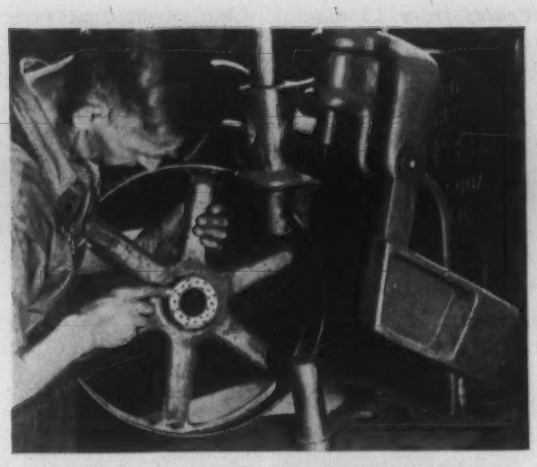
IN THAT "TOUGH SPOT" PUT



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Metaline Bearings are made of high grade bronze in one and two piece types, plain or flanged, in a wide range of sizes. We can accept war orders and other orders with proper certification.

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BARIUM STAINLESS STEEL CORPORATION
Canton, Ohio

24. Miss Elsie P. Garvin, Eastman Kodak Co., Rochester, N. Y., is chairman of the Science-Technology group.

The paper, "Arc Welding Versus Casting in the Design of Jigs and Fixtures," by Herman J. Brenneke, of New York University, won the first award of $1000 in the Engineering Undergraduate Award & Scholarship Program of the *James F. Lincoln Arc Welding Foundation,* Cleveland. He received the additional honor of having four scholarships of $250 each presented in his name to his University's Department of Mechanical Engineering. The description indicated a saving in cost of $45.18, and a saving in time of 17 hrs. Topics for the second and third prize winners were an arc welded chair and a radio tower.

A new library of welding, believed the most extensive in existence, has been established at the Ohio State University, Columbus, according to E. N. Manchester, university librarian. It is the gift of A. F. Davis, vice president and secretary of the Lincoln Electric Co., Cleveland, and is named after him. The library is expected to be of special value to industrial designers, engineers, technicians, etc. Though in the early stages of development, it now contains over 700 books, including those on metallurgy, designing for welded construction, welding technique and procedures, properties of weld metals, standard welding textbooks, bound volumes of welding magazines, patents relating to welding, etc.

News of Metallurgical Engineers

Thomas N. Armstrong, metallurgist since 1935 with the Development and Research Department, International Nickel Co., is now also a part-time member of the staff of the War Metallurgy Committee of the National Academy of Sciences—National Research Council. His professional interests have included alloy steels, ordnance and welding.

C. E. Powell has been appointed manager of the machinery department of the R. D. Wood Co., Philadelphia. He is well known in the hydraulic machinery field, and has contributed many ideas during this war to high-speed press and control design for hydraulic forging of nonferrous and aircraft metals. A graduate of Carnegie Tech., he has been with Pittsburgh Crucible Steel Co., Worthington Pump & Machinery Corp., and Homestead Valve Mfg. Co.

G. Donald Spackman has been elected vice president in charge of operations of the Lukens Steel Co., Coatesville, Pa. In his new position he will be responsible for operations at Lukens and its two subsidiary companies.

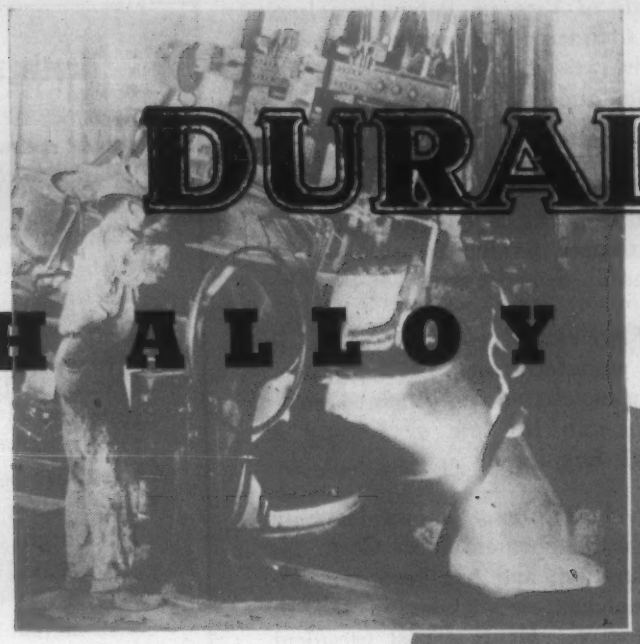
C. C. Herman has been made general manager of Claude B. Schneible Co., Chicago, maker of industrial dust collector systems. He was formerly chief engineer with that company, and in previous years had been with the engineering department of John Deere & Co. in the Moline and Waterloo plants.

Everett Chapman has resigned the presidency of Lukenweld, Inc., Coatesville, Pa., to establish his own consulting engineering business. Among his previous positions were teacher of electrical engineering at Purdue University and experimental engineer with Lincoln Electric Co., Cleveland. He is one of the country's leading welding experts.

Harold F. Haase has joined Battelle Memorial Institute, Columbus, where he will do electrochemical research. His former affiliations include research positions with A. O. Smith Corp. and American Can Co.

James L. Francis has joined the metallurgical staff of the Meehanite Metal Corp., New Rochelle, N. Y. He was formerly with Vulcan Foundry Co., Oakland, Calif.

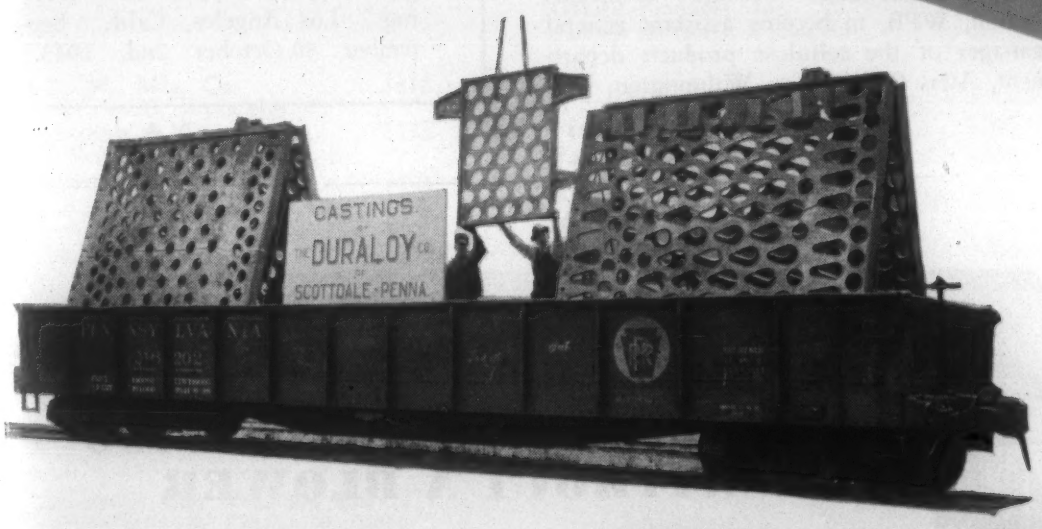
Gordon Lefebore has been elected president and general manager of the Cooper-Bessemer Corp. He is a man who has had much industrial production experience. He

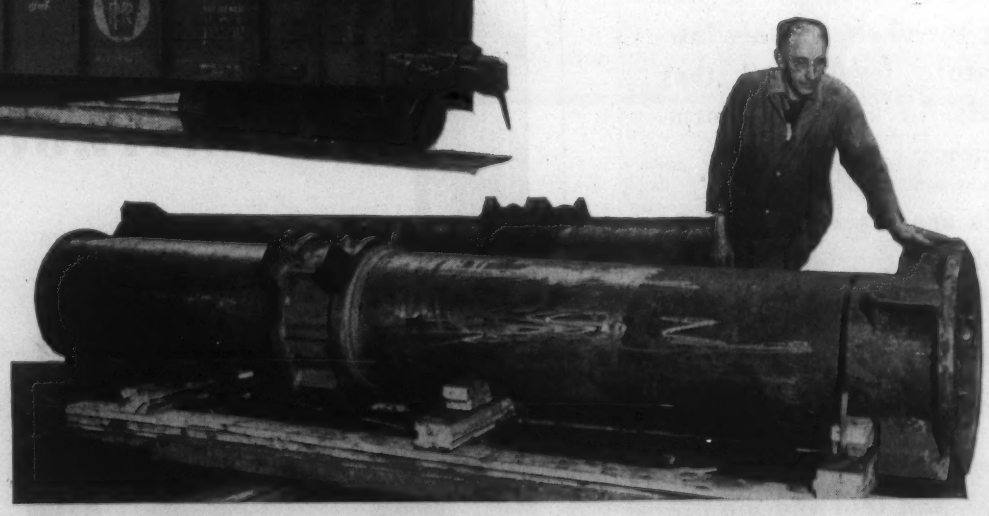


DURALOY

HIGH ALLOY CASTINGS

20 Years' Service to Industry





Twenty years in the history of this country is not long. But in the history of chrome-iron and chrome-nickel castings it covers just about all of it. For we were among those who did the pioneering work in high alloy castings back in the early twenties.

All of this points to the most important requisite if a foundry is to serve industry along these lines. That requisite is *experience*.

That our metallurgists and foundrymen can look back upon so many years of service is indicative of the service they can give you today.

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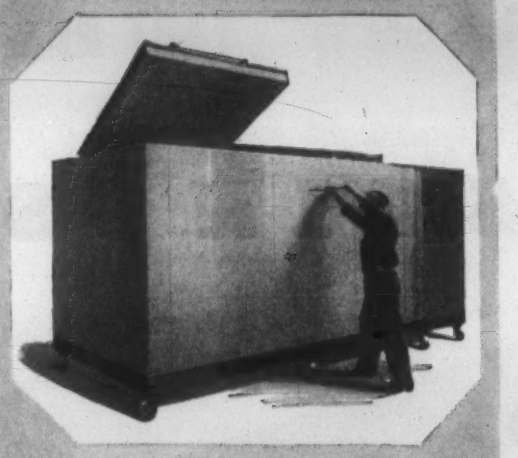

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Aluminum alloy 17S-T and 24S-T sheets and spars must be protected from air-hardening until used . . . just as rivets of the same alloys are protected.

KOLD-HOLD Aluminum Sheet Storage Units afford this protection by pulling the sheets down to –20° F. just after the quenching process . . . and holding the sheets at this low-temperature level until they are ready for use at the forming station.

Sheets are placed on end in the cooler . . . and rest on removable wooden racks. Free air circulation cools sheets uniformly . . . making them more pliable. Forming is effected with less stress and strain on the metal, and tool and die life of the press is prolonged through reduction of shock load.

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KOLD-HOLD MANUFACTURING CO.
436 N. Grand Ave., LANSING, MICH., U.S.A.

is a graduate of Virginia Polytechnic Institute and attended West Point. Several years ago he was in charge of production of Chevrolet and was later vice-president in charge of General Motors activities in Canada. He was also in charge of the Diesel Engine Division of the American Locomotive Co. More recently he has helped coordinate production of war materials in the U. S. and Canada.

Adam MacKenzie, vice president in charge of manufacturing, Carboloy Co., Inc., has been elected chairman, Detroit section, American Institute of Mining & Metallurgical Engineers.

Frederick A. Westphall is on leave of absence from the Sheffield Steel Corp. for the war's duration, and has been commissioned a lieutenant-commander in the U. S. Naval Reserve. He is a past president of the Wire Association. In previous years he was with the American Steel & Wire Co. and Jones & Laughlin Steel Corp. During the first war he served with the artillery, and was decorated for gallantry in action and meritorious services.

E. H. Bucy has resigned as chief of the Protective Coatings Section, Chemicals Section, WPB, to become assistant general manager of the cellulose products department, Atlas Powder Co., Wilmington, Del.

Meetings and Expositions

SOCIETY OF AUTOMOTIVE ENGINEERS, war materials meeting. Detroit, Mich. June 9-10, 1943.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, semi-annual meeting. Los Angeles, Calif. June 14-16, 1943.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, national technical meeting. Cleveland, Ohio. June 21-25, 1943.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting. Pittsburgh, Pa. June 28-July 2nd, 1943.

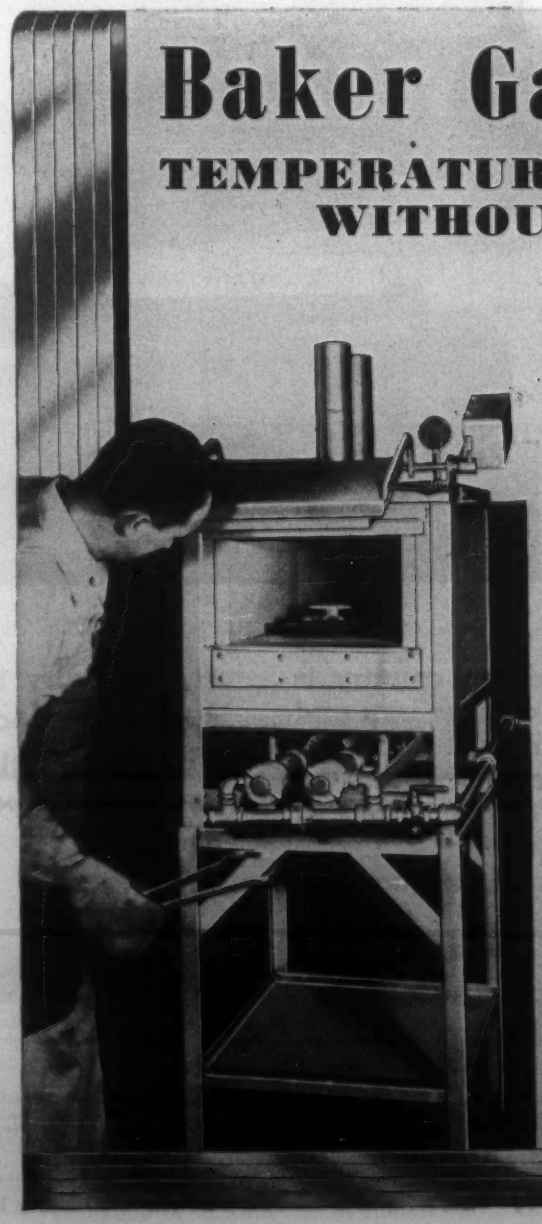
AMERICAN CHEMICAL SOCIETY, semi-annual meeting. Minneapolis, Minn. September 6-10, 1943.

SOCIETY OF AUTOMOTIVE ENGINEERS, national tractor meeting. Milwaukee, Wis. September 23-24, 1943.

SOCIETY OF AUTOMOTIVE ENGINEERS, national aircraft engineering and production meeting. Los Angeles, Calif. September 30-October 2nd, 1943.

Baker Gas Furnaces

TEMPERATURES UP TO 2400° F. WITHOUT A BLOWER



BAKER Blowerless Gas Furnaces are very low in gas consumption, noiseless in operation, reach the required temperature rapidly and are equipped with thermocouple and accurate pyrometer. The research departments of some of the largest corporations have contributed to making their high efficiency possible.

There are 9 standard stock models ranging in size from No. 1 (Bench type), which is 6″ x 8″ x 5½″, to No. 24, which is 12″ x 20″ x 8″ as illustrated. All provide uniform, controlled heat up to 1900° F.

Model No. 5, 6″ x 12″ x 5″, is built especially for treating high speed steel. Gives uniform, controlled temperatures up to 2400° F.

We stock one Hydrogen Atmosphere furnace, No. 12, with a closed muffle 8½″ x 15″ x 2½″ high.

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By Edwin F. Cone

Stainless Steel Airplanes

Some interesting testimony regarding the use of stainless steel in airplane construction comes from Col. E. J. W. Ragsdale of the Edward G. Budd Mfg. Co., in an address before the Philadelphia section of the Society of Automotive Engineers. He said in part: Stainless steel is an ideal material with which to work. Several years ago I predicted that stainless steel would find its way into aircraft construction through the fire route. It has done just that because at 1200 deg. stainless steel has retained more strength than plain carbon steel ever had even at room temperature. Even more remarkable than its resistance to heat is that characteristic of stainless which enables it to retain its impact resistance when cold. At 100 deg. below zero it is the same as at room temperature. Stainless steel is really handicapped with its misnomer. Its reputation is well known for resistance to corrosion, but its ability to withstand heat, cold, fatigue, and impact is not yet common information.

Nickel Pig Iron

One large American steel producer has been experimenting with the use of alloy scrap in blast furnaces with the result that 0.50 to 1.50 per cent Ni has been introduced into the pig iron. This iron is being used for direct charging into steel making furnaces — an indirect way of making an alloy steel containing nickel.

Effective March 3, the OPA added $2 per ton to the base prices of pig iron containing 0.50 to 0.75 per cent Ni with $1 a ton allowed for each additional 0.25 per cent.

Steel Bars

The output of hot-rolled carbon steel bars last year amounted to 6,589,000 net tons of 2 per cent in excess of the 1941 total.

Alloy steel bar output in 1942 was 2,512,000 tons which is almost 20 per cent above the best previous record.

Output of tool steel bars last year was 210,000 tons, also above the 1941 level.

Tantalum

Much of the tantalum used in this country has been imported Announcement is now made by the U. S. Bureau of Mines that a deposit of tantalum ore has been discovered in New Mexico. Preliminary research work on this ore seems to indicate high percentages of tantalum. The Metals Reserve Co. is reported as paying $3.50 per lb. or $7000 a net ton for the concentrates that are being stocked at Rolla, Mo.

Useful Ideas of Employees

Suggestions by plant employees are proving an important factor in the war effort. Westinghouse reports that more than 500,000 extra man-hours were added to the nation's war effort in 1942 through suggestions made by employees. These suggestions also conserved hundreds of tons of vital materials—copper, steel, aluminum and rubber—and increased the output of machine tools and other equipment. War workers in 25 Westinghouse plants and 14 offices last year handed in 22,788 ideas. Of these 7365 or 36.4 per cent were good enough to put to use.

More Demand for Alloy Steel

The war program is constantly increasing the need for alloy steel—one out of every 6 tons of steel produced now is alloy steel. The proportion of alloy steel to the total steel output has risen steadily over the past year and more, and shows no signs of diminishing.

To meet this demand more alloy steel of certain grades is being made in open-hearth furnaces. Such furnaces are producing only 3 heats of alloy steel in the same length of time that they formerly produced 4 heats of plain carbon steel, according to the American Iron and Steel Institute.

Rate of Steelmaking

A recent survey of steel producers by the American Iron and Steel Institute has revealed the fact that the more than 1200 steel furnaces in the country were either in production or else undergoing routine maintenance work 99.7 per cent of the year—a new high rate of activity by a wide margin. Although the furnaces were in operation 99.7 per cent of the time, the total tonnage of steel produced during the year represented only 96.8 per cent of the industry's rated capacity—largely because wartime emergency conditions have lengthened the average time to make a heat of steel.

Expansion in Electric Steel

Some measure of the degree of expansion of the American electric steel industry is available from a comparison of the output of that industry for the first quarter of this year with that of the same period in 1942. The total to April 1, this year, was 1,095,146 net tons—for the same 3 months a year ago it was 898,075. This is an increase of over 197,700 tons for this year.

Total Steel Output for 1943

At 21,920,278 net tons as the steel ingot and castings production for the first quarter of this year, the 1943 total will not be less than 87,700,000 tons if the volume is maintained. The total for the first quarter is over 903,500 tons in excess of that for the same period a year ago.

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METALS and ALLOYS

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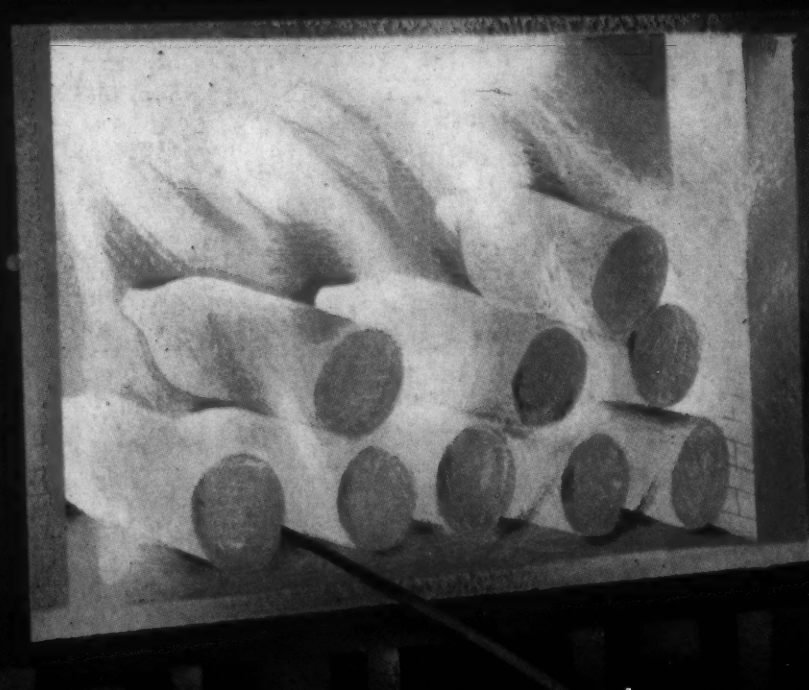

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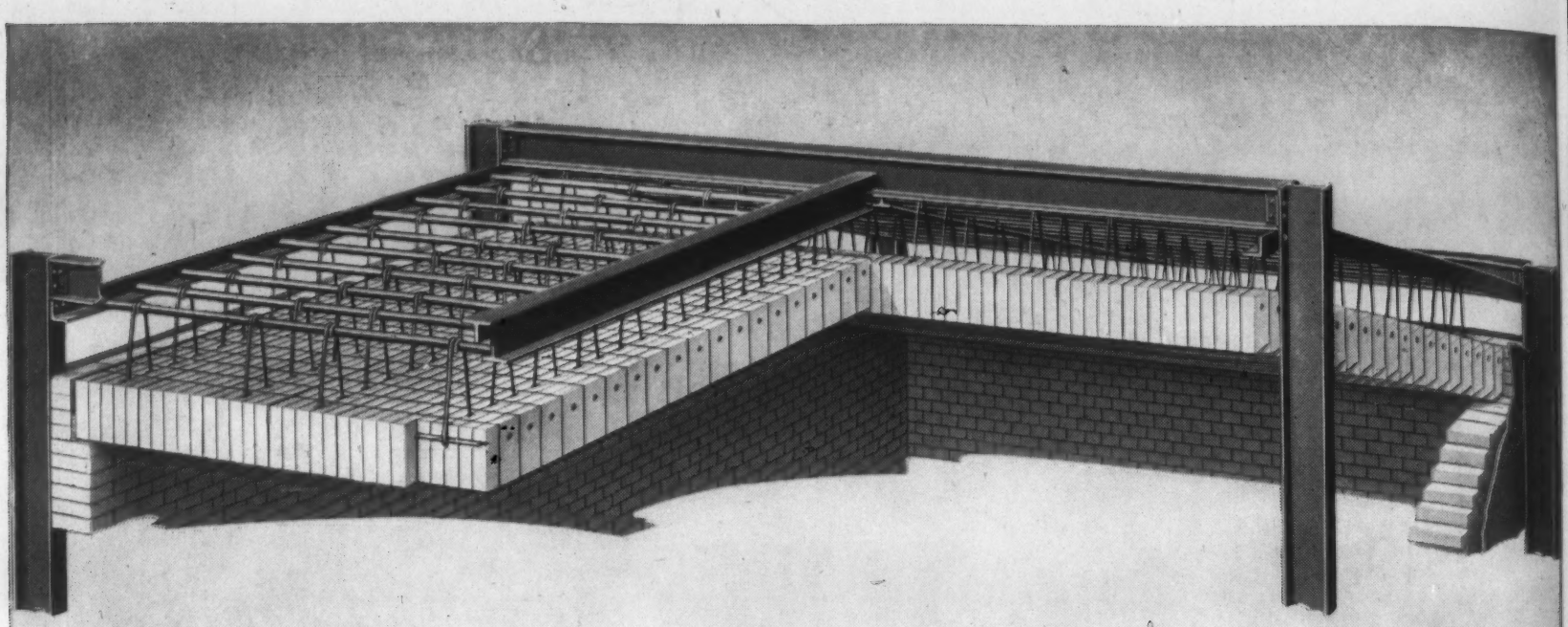

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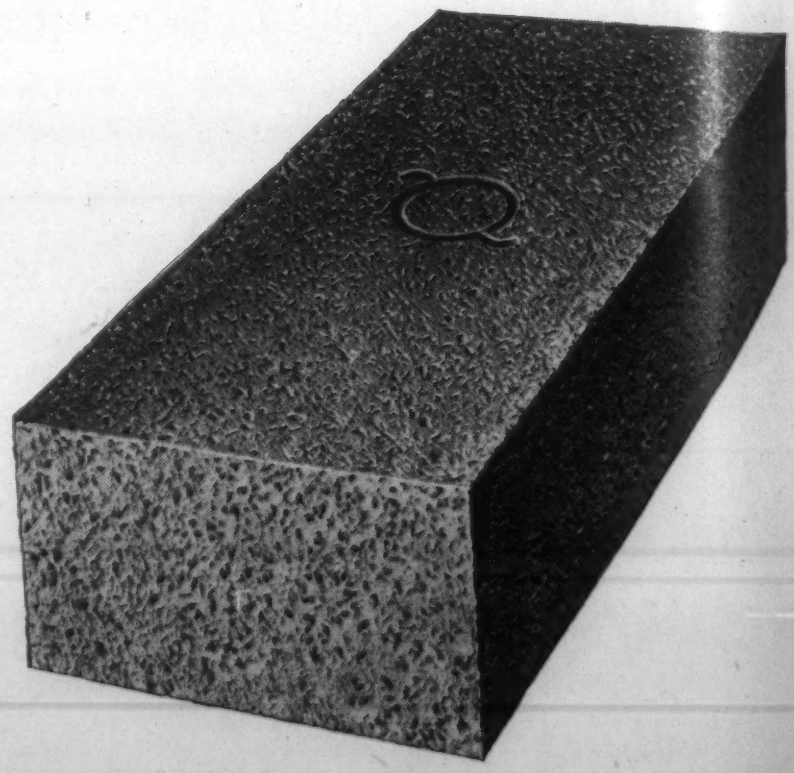

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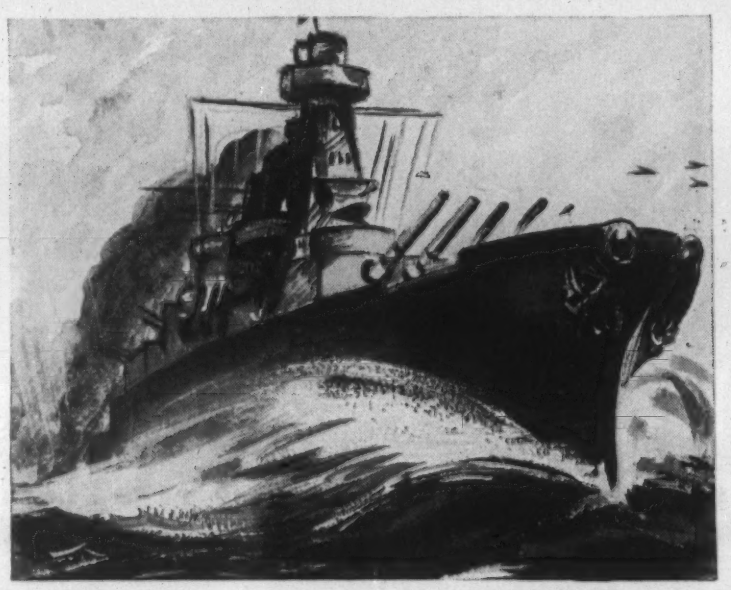

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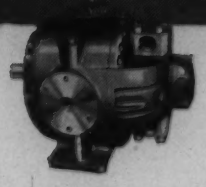

THEY'RE BUILDING

A-C WELDING is used extensively by most of the tank manufacturers. It is one of the important factors contributing to the rapid production of these mighty weapons of war. Shown above is a line of operators welding bogie wheels for 28-ton tanks in a plant of the Baldwin Locomotive Company.

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1 Up to 36% faster welding—In many cases higher current and larger electrodes can be used for greater speeds. Many users report speed-ups of 15 to 36 per cent after changing from d-c to General Electric a-c welders.

2 It's easy to get high-quality welds—The absence of troublesome arc-blow makes it easier for the operator to control the molten pool. The danger of undercutting and inclusions is greatly reduced—uniform welds are more easily made.

3 Less distribution copper required—A-c welders can use the same power circuits as d-c welders. Or, when new lines are being put in, a-c welders require considerably *less* copper than d-c welders. In addition, they save up to 50 per cent in power because of their higher efficiency.

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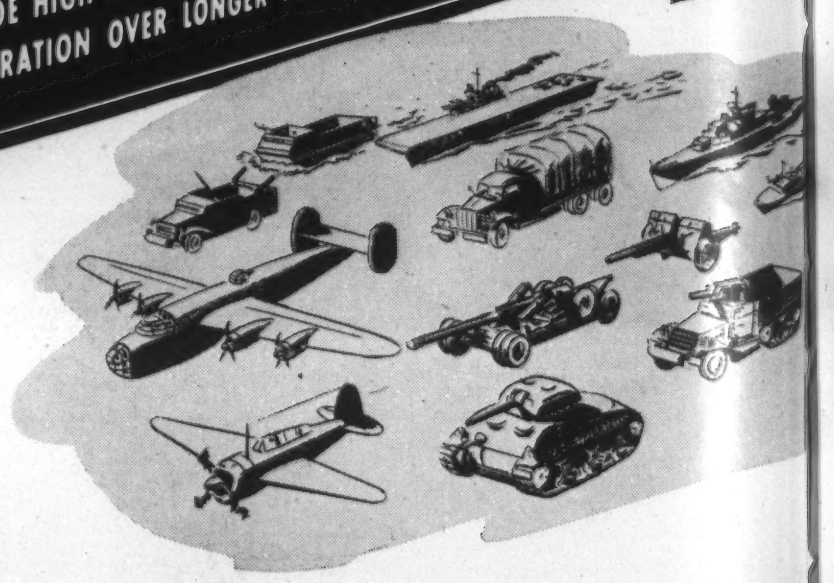
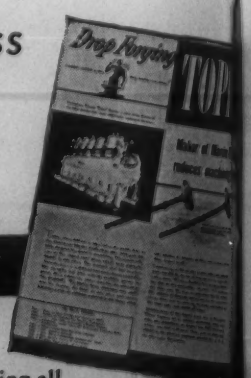


Evidence substantiating the 7 advantages which forgings offer has been published in Drop Forging Topics.

Are you obtaining the utmost of every advantage that forgings offer?

Are you using forgings for the first time? Then, may we suggest that you check your use of forgings against the 7 advantages that forgings offer to be sure that you are obtaining the utmost of every advantage. Even to those manufacturers who have had a long experience in the use of forgings, the re-checking of every forging part, against the 7 advantages that forgings offer, has revealed further opportunities to reduce weight and conserve critical metals, or indicated a faster method for machining and finishing forgings. This checking need not be difficult or wasteful of time. Assistance for such a check-up is available from forging engineers connected with your source of supply. Utilize their broad experience to obtain the fullest measure of benefits from your use of forgings. Begin your check-up now!

FORGINGS ARE AS VITAL TO VICTORY AS THINKING IS TO PROGRESS



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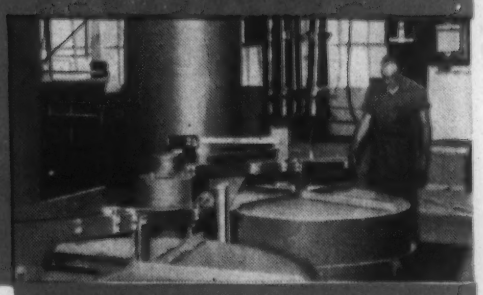

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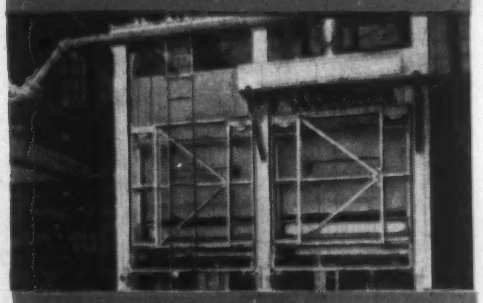

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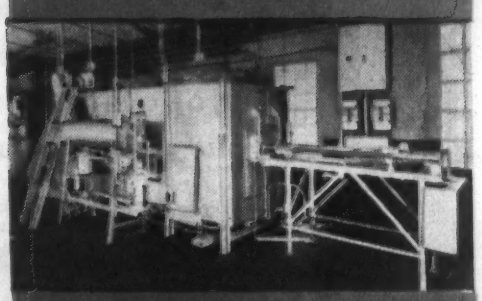

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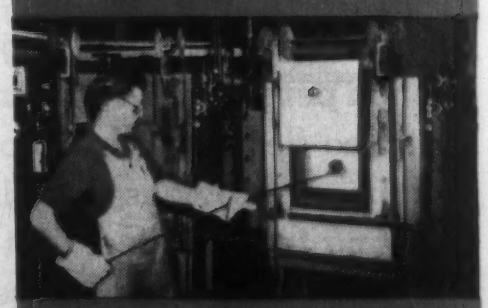

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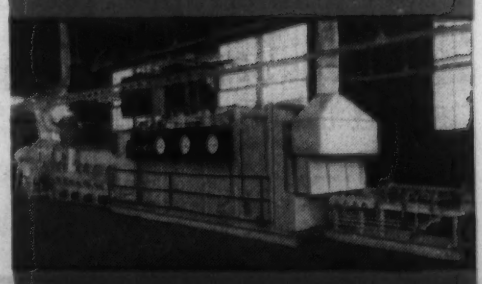
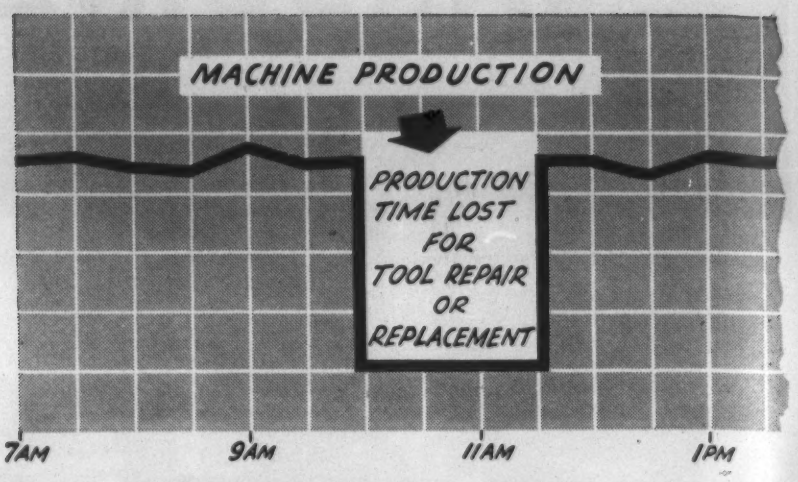
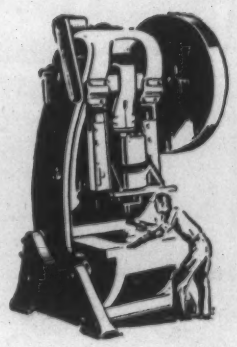


PUSHER FURNACE

ROLLER-HEARTH FURNACE

How to reduce PRODUCTION INTERRUPTIONS caused by tools





Certainly one of the biggest problems of round-the-clock production is finding ways to prevent loss of production time caused by frequent shut-downs to redress or replace tools that wear too rapidly or fail too soon. If *you* could get several hours, or even ten minutes, extra production time per day from each machine in your plant, wouldn't it make *your* production schedules easier to meet?

Here is a Method for Solving the Problem

Many busy war plants have found the answer to the problem of getting more production per machine by using the Carpenter Matched Set Method of tool steel selection. Because it provides a definite *system* for selecting the one steel that is best for each tool, this method helps to get tools that give longer uninterrupted production.

Thousands of successful applications have proved that the Matched Set Method definitely helps to get more productive time from machines and tools. On the opposite page are four actual production line examples of how the Carpenter Matched Set Method has helped others get increased output from present equipment.

If you are anxious to get better tool performance in *your* plant—longer *uninterrupted* production runs—the Carpenter Matched Set Method can help you. The two books below can help you put this method to work in your plant.

For "Refreshing" Skilled Tool Makers and Training New Men. More than 35,500 copies of this text book are now in use. Copies are available to tool steel users in the U.S.A. *at cost,* $1.00—$3.50 elsewhere.

For Tool Room Foremen and Tool Hardening. A 167-page manual with a comprehensive explanation of the Matched Set Method of Tool Steel Selection, detailed heat treating data and hardening instructions. *Free* to tool steel users in the U. S. A.

HOW OTHERS HAVE STEPPED UP PRODUCTION PER MACHINE

A DIFFERENT KIND OF PUNCH

Fig. 1

JOB: A "shaving" punch for "staking" the lug indicated by the arrow in Fig. 1. This small punch cuts only on one side—the job is done in one blow—and the material is mild steel.

PROBLEM: As any tool maker will appreciate, the trouble was punch breakage. A *good* punch lasted only a few hours and the rest didn't last long enough to pay for setting them up.

SOLUTION: The Carpenter Matched Set Method indicated that a *tough* steel was needed—so the tool maker picked the toughest of the lot, SOLAR (Water-Tough).

RESULT: To the amazement of everybody, the first Solar punch put in the press ran for a week! The job was licked—and stayed licked.

WANTED— HIGHER PRODUCTION

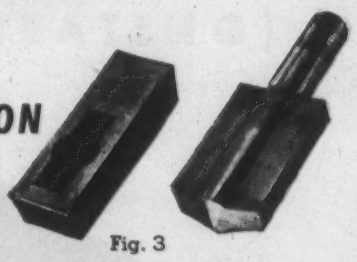


Fig. 3

JOB: Punching 3/16" thick O.H. steel sheets—19 punches and dies (Fig. 3) to the set-up. As this was a very *tough* job, the steel first tried was Carpenter's R.D.S. (Oil-Tough), toughest of the Oil-Hardening Matched Set. This gave 190,000 holes between grinds.

PROBLEM: To step up production per grind—so as to cut down shut-down time required for regrinding.

SOLUTION: Reference to the Matched Set Method indicated that greater wearing qualities could be obtained by moving north from R.D.S. to STENTOR (Oil-Hard).

RESULT: Punches and dies made from Stentor stepped up production *over 100%*—to 387,000 holes per grind. And here is an important point—while Stentor was chosen for its greater *hardness,* it also proved to have sufficient *toughness* to handle the job.

FOLLOWING THE ARROWS TO GREATER PRODUCTION

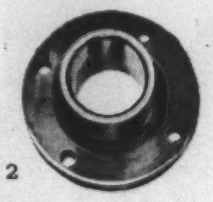


Fig. 2

JOB: A combination punch and die that works on cold rolled strip steel (Fig. 2).

PROBLEM: This tool had been made of high carbon tool steel—but it seemed impossible to get away from galling and scratching the work. Efforts to make the die "glass hard" only served to make the tool so brittle that the thin wall would break. The best production had been 600 pieces.

SOLUTION: The tool maker turned to the Matched Set Diagram, put his finger on the middle diamond and said, "Here is about where I am—and I want greater wear resistance." The arrow pointed north to K-W (Water-Wear), so the next tool was made from that steel.

RESULT: Production increased to *12,000 pieces!*

TWO JUMPS TO FIND THE ANSWER

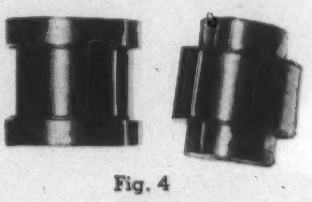


Fig. 4

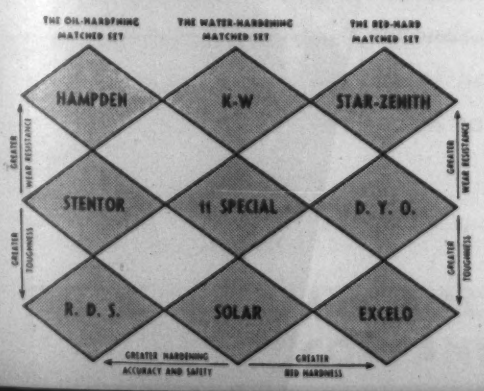
JOB: Making 3" diameter rolls used for rolling a bead on stainless strip .008" thick. Note the thin edge on the bead.

PROBLEM: When made of carbon tool steel, the thin bead cracked in hardening, so the Matched Set Method was followed to STENTOR (Oil-Hard) for "greater hardening safety." When made of Stentor, the bead stayed on in hardening safe enough, but when placed in service the strain was too much for the thin section in this hard steel, and the edges chipped.

SOLUTION: Referring again to the Matched Set Method indicated that moving south to R.D.S. (Oil-Tough) would provide greater *toughness.*

RESULT: Made of R.D.S., the rolls shown in Fig. 4 had turned out "miles" of molding when this picture was taken—and the bead is still there!

Important before—VITAL NOW!



The actual job examples outlined above show how others have used the Carpenter Matched Set Method to reduce production interruptions and increase output. Your Carpenter representative will be glad to show you how it can be applied to your particular requirements.

THE CARPENTER STEEL COMPANY
135 BERN ST., READING, PA.

Carpenter MATCHED TOOL STEELS

BRANCHES AT Chicago, Cleveland, Detroit, Hartford, St. Louis, Indianapolis, New York, Philadelphia

"Have You Investigated t

It Pays to

the Possibilities of Van Norman HFIH?*"

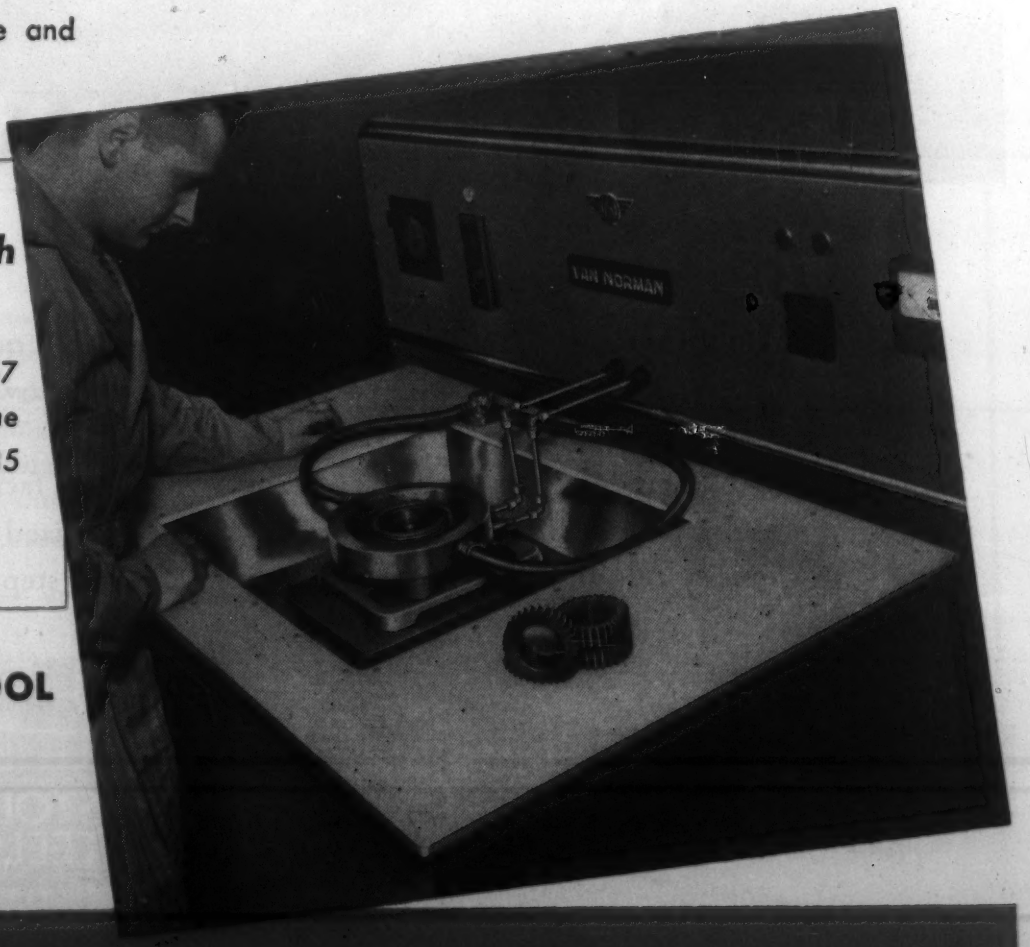
(*HIGH FREQUENCY INDUCTION HEATING)

Because Van Norman High Frequency Induction Heating speeds up production, cuts costs, and provides a better finished product — more and more design engineers, production engineers and plant executives are turning to High Frequency Induction Heating for surface hardening, brazing, soldering, and a host of other heating applications. The reason . . . High Frequency Induction Heating provides quick, localized heat to a specific portion or area of metal. This not only simplifies heating operations but also saves considerable time. In fact, many heating jobs are completed in seconds as compared to hours when previous methods are used. In addition, warping, distortion, scale and straightening operation are minimized or entirely eliminated. And because the entire heating operation is automatic, Van Norman High Frequency Induction Heating eliminates chance of human error — thus part after part is turned out with identical characteristics. A typical surface hardening application is shown below.

Yes, you, too, can profit with HFIH. So investigate Van Norman High Frequency Induction Heating today. A complete story of their advantages, possibilities and applications will be sent on request. Write for your copy.

Surface Hardening Gear Teeth in 23 Seconds

Gear teeth are hardened to 55-57 Rockwell C in 15 seconds. Quench time is 8 seconds. Depth of hardening .035 to .045. Material-plain carbon steel.



VAN NORMAN MACHINE TOOL COMPANY

Springfield, Massachusetts

Van Normanize

Uniformity of thermal treatment and dependable quality in all finishing operations, are essential in the making of a steel that will flow smoothly and rapidly through your production machinery.

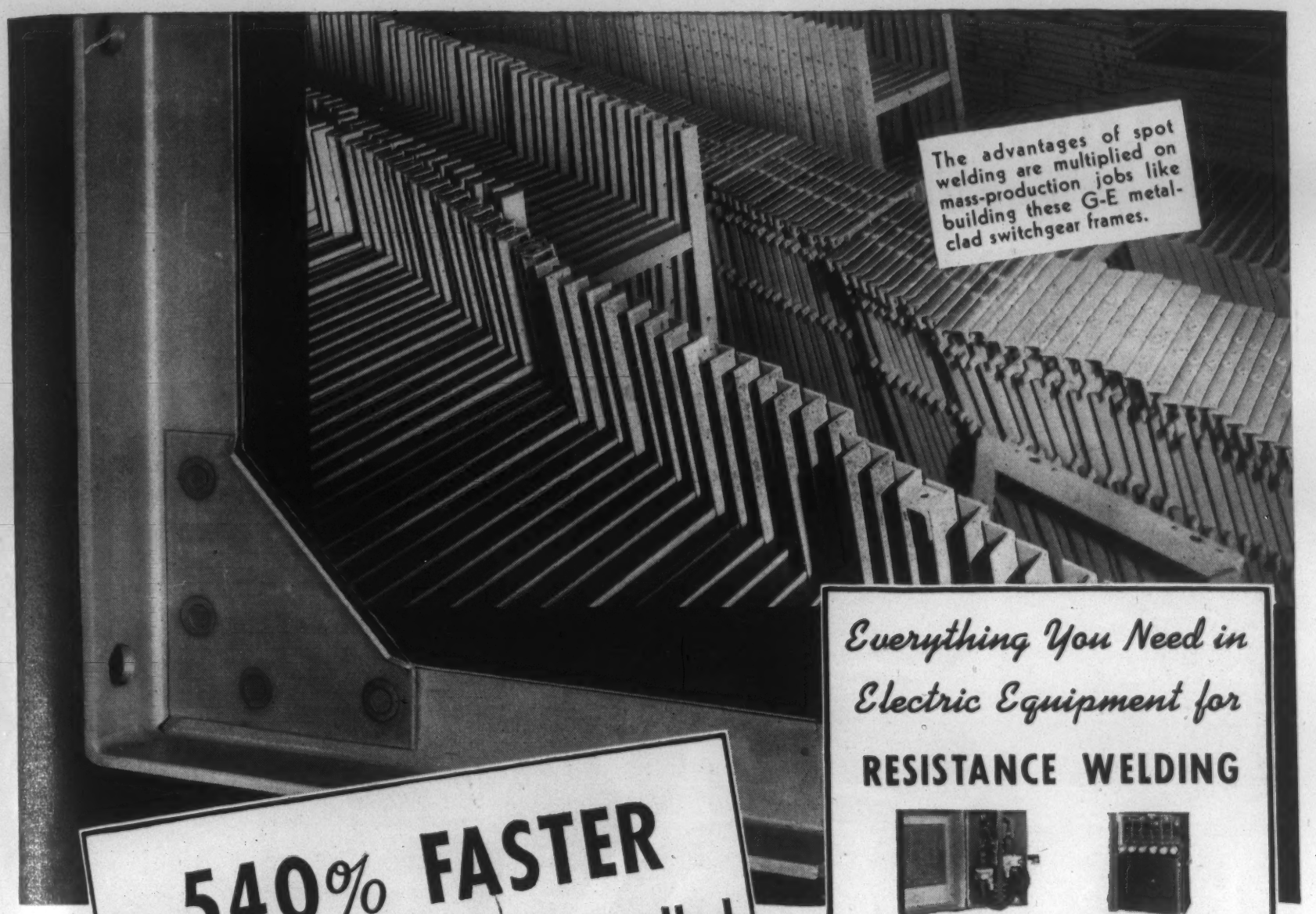
The modern and extensive Aristoloy finishing facilities, are completely integrated and assembled in our Warren plant. This centralized manufacture results in undivided quality responsibility through each steel-making step from melting to finishing.

COMPLETE MODERN FACILITIES FOR
annealing and heat treating
rough-turning • centerless grinding
turning and polishing • cold drawing

ARISTOLOY STEELS

CARBON TOOL STEELS
ALLOY TOOL STEELS
AIRCRAFT QUALITY STEELS
BEARING QUALITY STEELS
STAINLESS STEELS · NITRALLOY STEELS

COPPERWELD STEEL COMPANY WARREN, OHIO



540% FASTER
with Electronically Controlled SPOT WELDING

SPOT-WELDING the thousands of corners for G-E switchgear enclosures speeded production 540 per cent over riveting; 375 per cent over bolting. Spot welding eliminated punching holes, inserting rivets or bolts, and the riveting or bolting operations—saving time, material, and man power.

Electronically controlled resistance welding is speeding the construction of light-metal and stainless-steel aircraft. It's replacing soldering, too, saving tin and time. Joining like or unlike metals and alloys. Giving dependable, *consistent* results. Making gastight seams. Helping speed the training of new operators. Resistance welding is ideal for high-production operations on heavy or light work, portable or fixed.

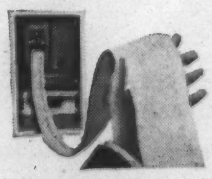
Whatever your application, be sure to specify G-E electronic control and other electric accessories. For further information, contact any G-E office, or your resistance-welder manufacturer or agent. Or write General Electric, Schenectady, N. Y.

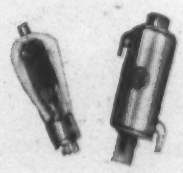
Everything You Need in Electric Equipment for

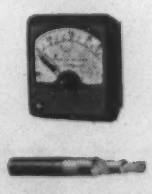
RESISTANCE WELDING

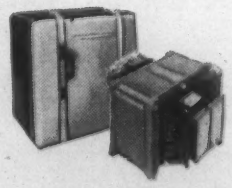
Electronic controls for spot and seam welders

Electronic weld and sequence timers

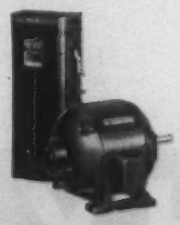

Weld-recorders—to record electrical input of EVERY weld


Electron tubes for all purposes


Cables and instruments


Air circuit breakers and welding transformers

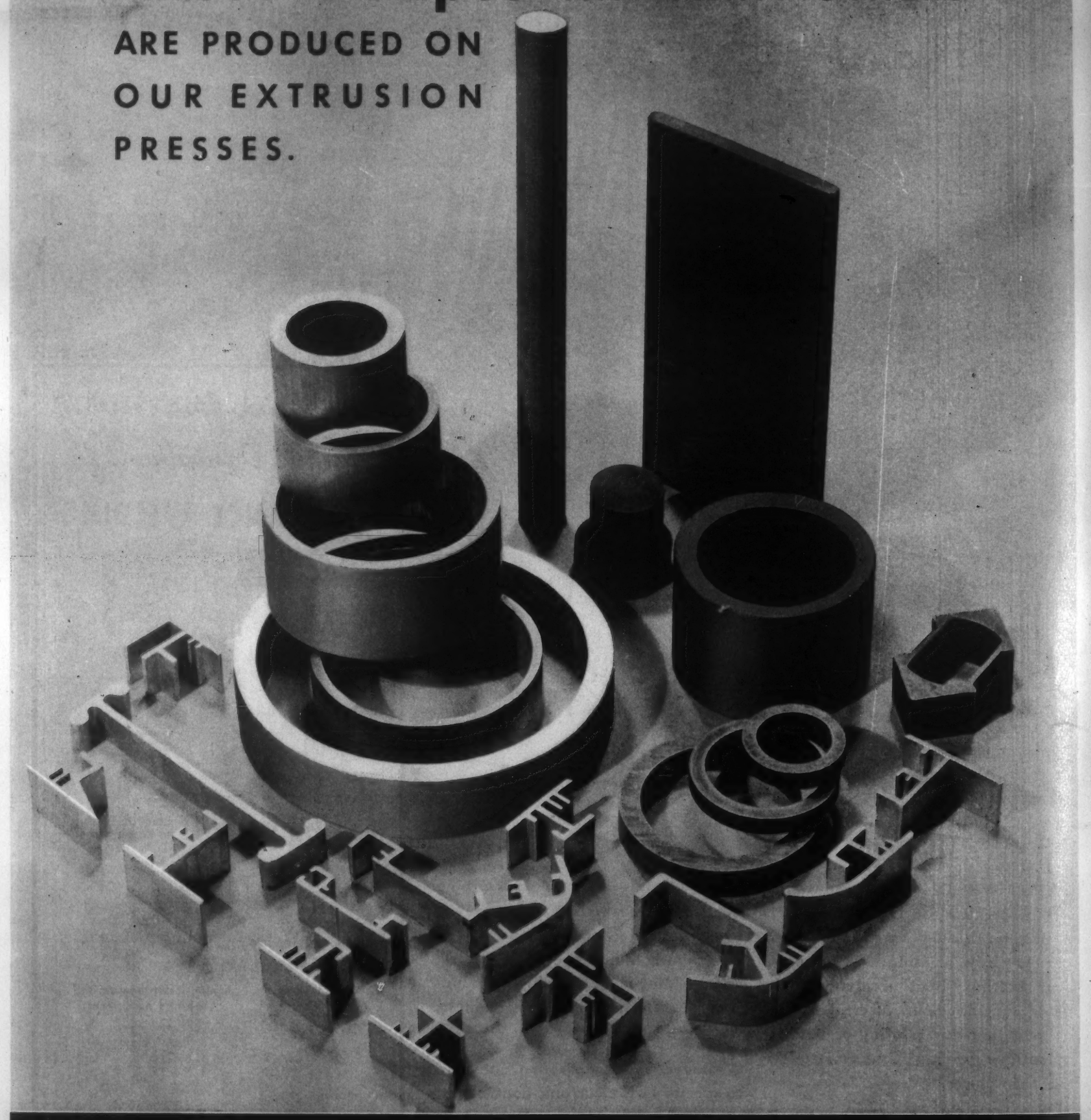
Capacitors for power-factor improvement


Motors and control

Speed Production Electronically

GENERAL ELECTRIC

These Shapes AND MANY OTHERS ARE PRODUCED ON OUR EXTRUSION PRESSES.



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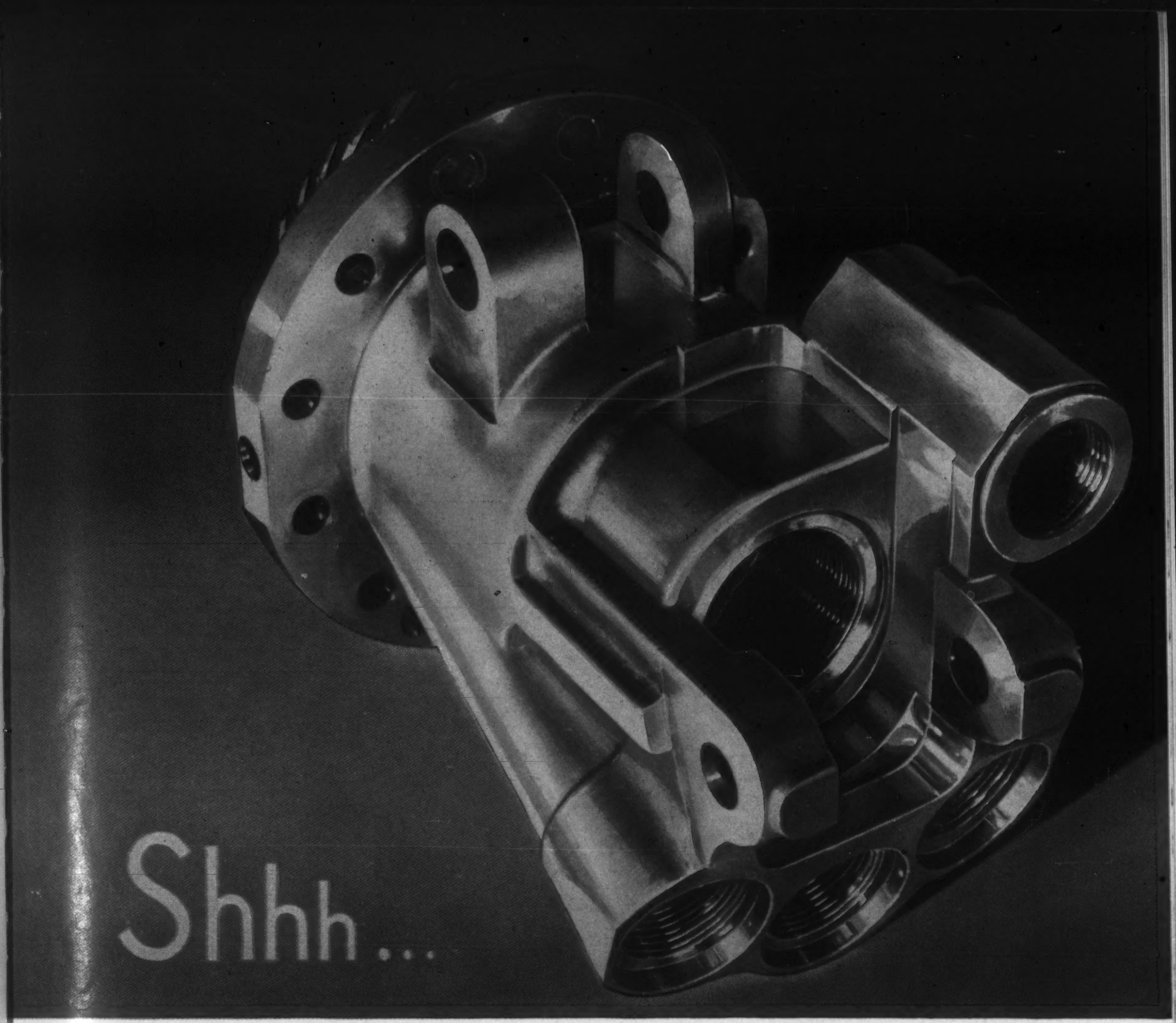


Illustration is approximately full size.

Sorry, we can't tell you what this is—or what it does. But it IS a beauty, isn't it? We *can* tell you that it started out as an Anaconda Hot Pressed Part, and that it was machined to its extremely close limits by the E. W. Bliss Co. It *should* give you an idea of what can be accomplished in the production of complicated parts of intricate design. Anaconda Hot Pressed Parts are strong, tough, close-grained and readily machined. They can be made of wrought copper, brass, bronze or special copper alloys . . . and design possibilities are almost unlimited.

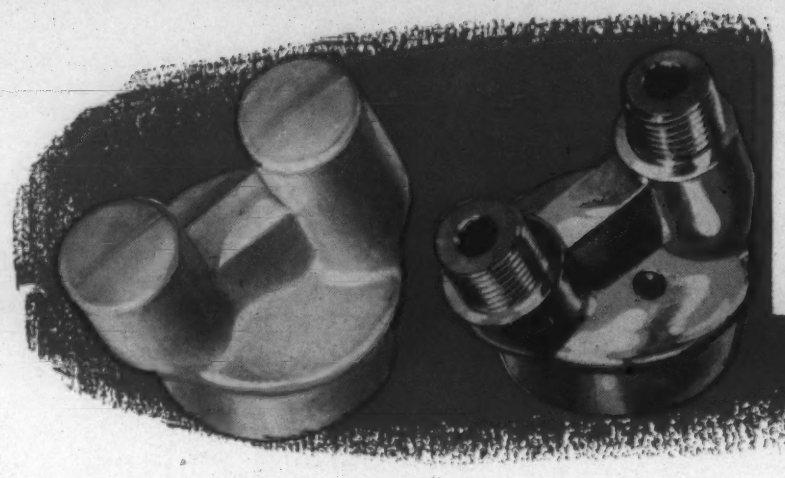
THE AMERICAN BRASS COMPANY, General Offices: Waterbury, Conn.

ANACONDA
from mine to consumer

Anaconda Copper & Brass

More about Anaconda Hot Pressed Parts and Pressure Die Castings on the following page.

Here's how to get a headstart on a Finished Product



Alexander F. Jenkins, President, The Alexander Milburn Company, manufacturers of welding and cutting apparatus, has this to say about Anaconda Hot Pressed Parts:

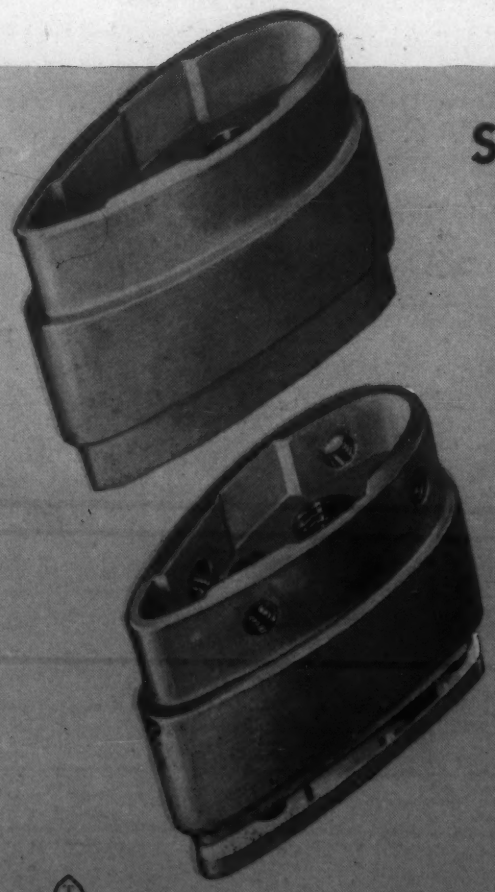
"Welding and cutting tool equipment is susceptible to a great deal of heat, gas pressure and rough usage. We have found Anaconda Hot Pressed Parts the only suitable material having the necessary fine-grain, leak-proof structure for such parts of welding and cutting tool torches. They require a minimum of finishing and possess physical properties which are highly satisfactory."

"Hot Pressed Parts...Require a Minimum of Finishing"

Point for point, this check list will help you compare your present materials with Anaconda Hot Pressed Parts.

1. Consistently accurate in dimension.
2. Freedom from internal defects.
3. Gas, air and water-tight.
4. Twice the strength of sand castings.
5. Uniform, dense grain structure.
6. Smooth, fine-texture finish.
7. Readily machined—very little scrap.
8. No sand—long tool life.
9. Available in copper, brass, bronze and special copper alloys.

If the production of complicated parts of unusual design is causing you concern, Anaconda Hot Pressed Parts may be the answer. They have proved to be an economical short-cut to a finished product in many instances. The check list at the left will help you compare Hot Pressed Parts with the sand castings, permanent mold castings, or other forms of material you may be using. If the use of a Hot Pressed Part indicates a possible cost saving, an improved product, a production speed-up, or release of important machining equipment, we'll be glad to talk it over.



See how quickly this Pressure Die Casting becomes a Finished Airplane Part!

On the left is an Anaconda Pressure Die Casting as supplied by The American Brass Company to the Dominion Electrical Mfg., Inc. This unique shaped part is a component of an Airspeed Tube, mounted on the wing to measure the speed of the plane. Drilling, tapping and slotting produce a finished part, as shown at the lower left, with a minimum of time, material and scrap. Anaconda Pressure Die Castings have most of the advantages of other types of die castings—*plus* higher strength, higher resistance to impact, greater hardness and ductility, and a high degree of corrosion resistance. While they do not have as dense a grain structure as Hot Pressed Parts, they are adaptable to more intricate coring and a wider range of design. Publication B-9 tells more about both of these Anaconda Products. Shall we mail a copy?

THE AMERICAN BRASS COMPANY

General Offices: Waterbury, Connecticut — *Offices and Agencies in Principal Cities*

Subsidiary of Anaconda Copper Mining Company

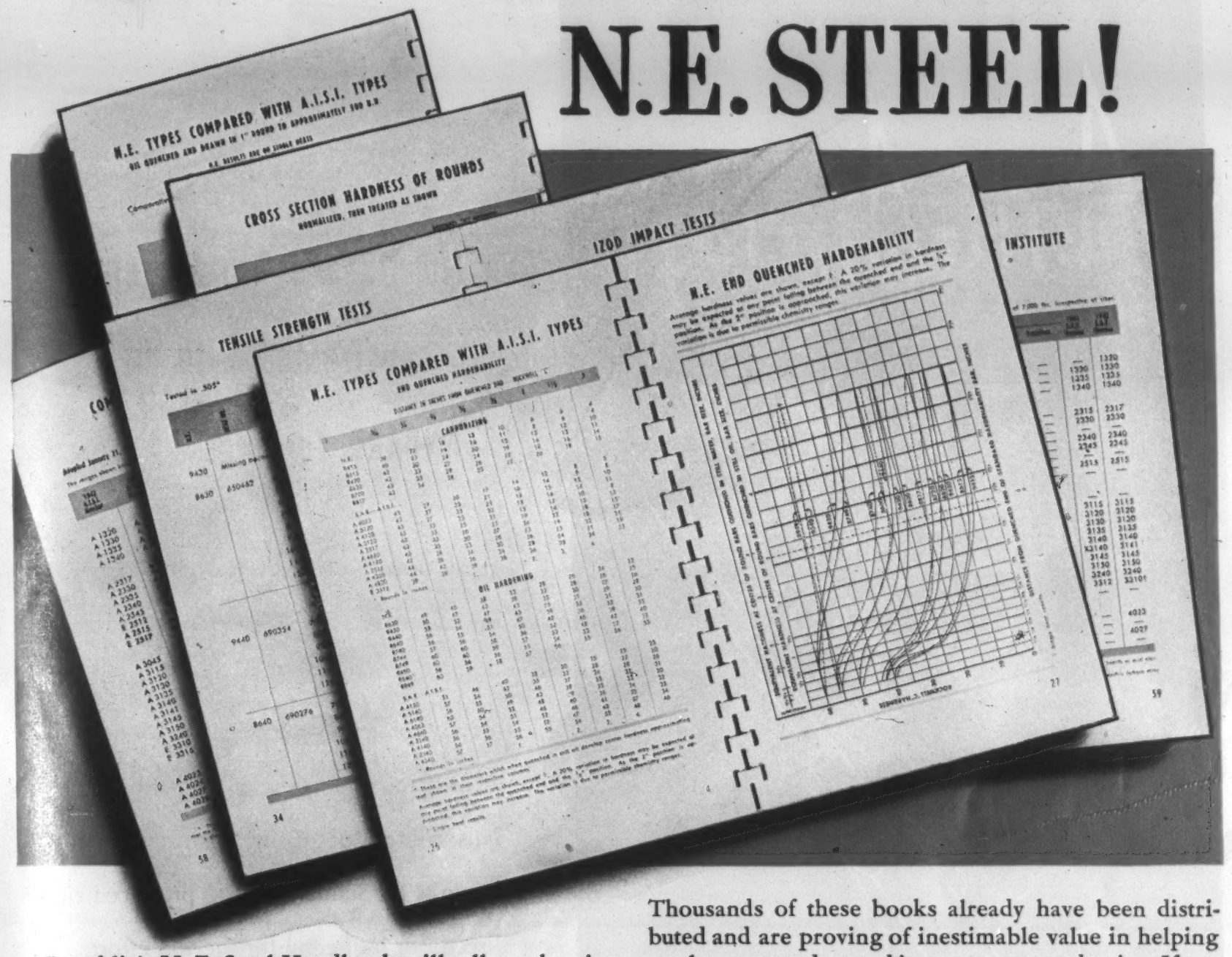
In Canada: ANACONDA AMERICAN BRASS LTD., *New Toronto, Ont.*

43106

ANACONDA
from mine to consumer

Anaconda Copper & Copper Alloys

How to select the correct N.E. STEEL!



● Republic's N. E. Steel Handbook will tell you how! It will bring you valuable facts and information prepared by the same men who helped develop the National Emergency Steels — Republic metallurgists.

This timely book offers an unusually complete description of the N.E. Steels, their chemical analyses, physical properties, their relationship to standard steels and why they substitute satisfactorily for high alloy steels.

It presents the very information you need on how to select the correct N.E. grade for each application, how to fabricate it and the precautions to exercise. It explains the end quench hardenability test and why it is used in predicting certain physical properties. It contains many useful tables, including combined standard lists of A.I.S.I. and S.A.E. steels.

Thousands of these books already have been distributed and are proving of inestimable value in helping steel users speed up and increase war production. If you are an engineer, metallurgist or production executive using N.E. steels, or if you contemplate changing to them, you should have a copy. Fill in and send the coupon below, and your book will be mailed promptly.

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Alloy **STEELS**

ARMY E NAVY

Gun Mounts and Gun Barrels are constructed with STANDARD forgings

Acid open-hearth steel, rigidly controlled through every phase of production at Standard, results in finished forgings with the high physical properties and high quality demanded in ordnance materiel for our armed forces. This control of quality also applies to all forgings by Standard being produced either directly or indirectly for the war effort.

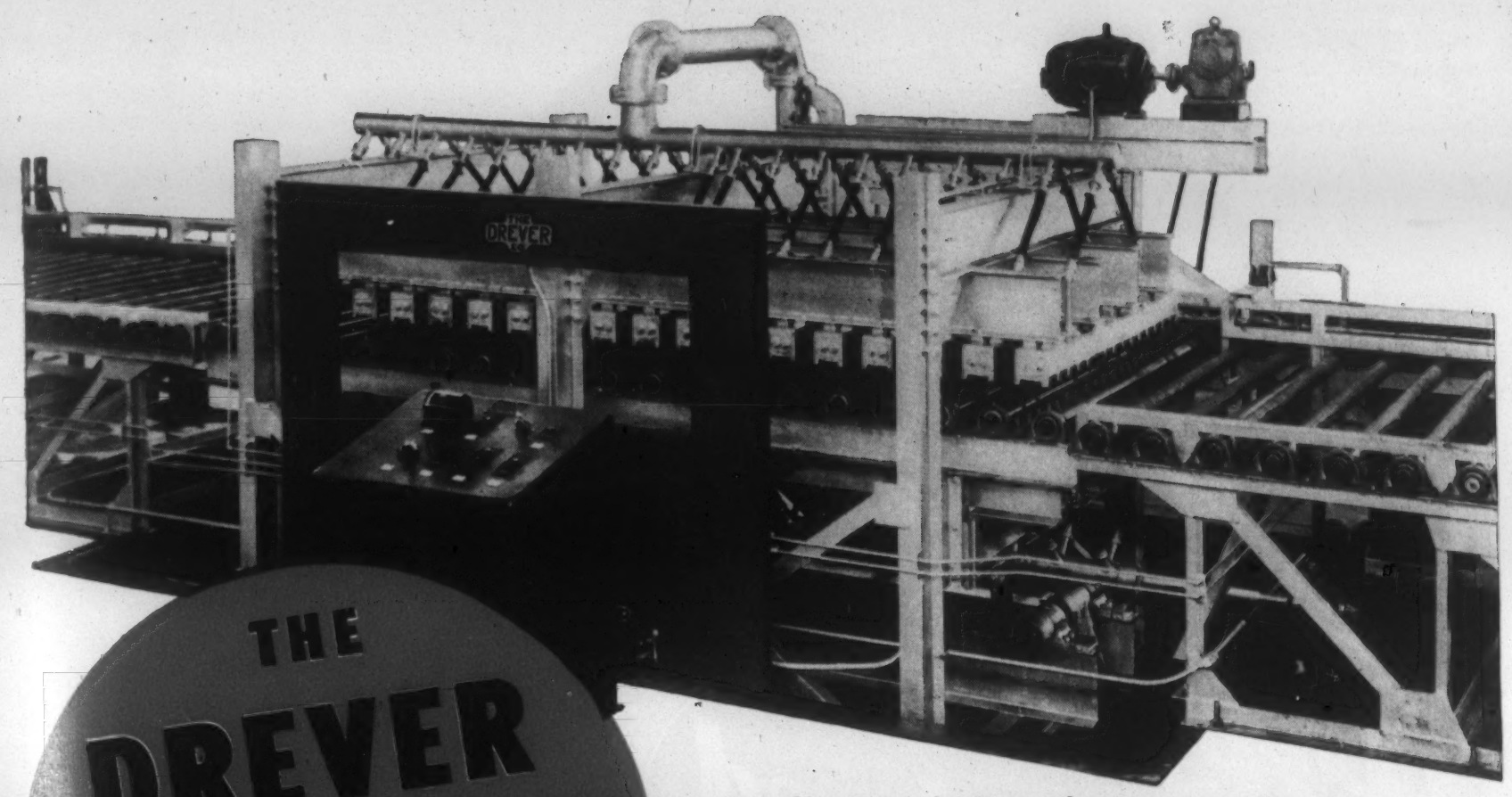
It is one of the major reasons why Standard steel products bear the reputation for dependability throughout peace-time industry and transportation as well as that of war.

BLW THE BALDWIN GROUP

STANDARD STEEL WORKS

DIVISION OF THE BALDWIN LOCOMOTIVE WORKS

PHILADELPHIA



THE DREVER PRESSURE QUENCH

"Straightens as it Quenches"

Saves up to 80% of Straightening Time on Plates!

The Drever Pressure Quench has given new values to the time required to produce straight armor plate, by eliminating distortion of plates during quenching. By means of hydraulically operated platens, the plate is held rigid under proper pressure during the entire water quenching cycle and no further straightening is required. The Drever Pressure Quench straightens and quenches in one operation, and actual reports from users show savings of as much as 80% in straightening time on plates from ⅛" thickness up.

Regardless of your present heat treating equipment, or your method of quenching, investigate the Drever Pressure Quench which straightens plates as it quenches.

IF IT'S HEAT TREATING EQUIPMENT **EXPERIENCE POINTS TO** THE DREVER CO

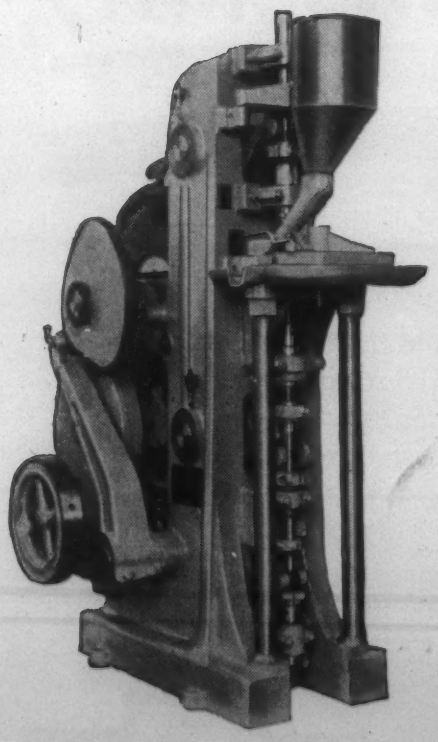
THE DREVER CO.

750 E. VENANGO ST.
PHILADELPHIA, PA.

Pressed from Powdered Metals

STOKES PRESSES

Save Labor, Time, Materials



These parts are typical of hundreds being pressed from powdered metals . . . ordnance components, iron gears, porous bearings, parts for electrical assemblies, radio, communications systems, Alnico magnets, hard carbide tool bits, etc. . . . on Stokes Automatic Presses.

Stokes pioneered the development of this type of press . . . equipment which is the result of 25 years of research . . . and is constantly engineering new models in capacities and types to meet ever-widening applications.

Let us make recommendations on methods, equipment and applications . . . consult with you on specific pressing problems. Our laboratory facilities are available for experimental work. Write for complete 48-page illustrated catalog.

F. J. STOKES MACHINE COMPANY

5972 Tabor Road Olney P. O. Philadelphia, Pa.

Representatives in New York, Chicago, Cincinnati, St. Louis, Cleveland, Detroit
Pacific Coast Representative: L. H. Butcher Company, Inc.

F.J.Stokes AUTOMATIC TABLETTING EQUIPMENT FJS Est. 1895

SHOWN ON THE WALL in the picture above is the second poster in the Heppenstall series for management—*Free Upon Request.* Simply write Heppenstall Company, Pittsburgh, Pa. and tell us how many you can use for the office walls of the people in your organization.

We undertook this series because we wanted to help the war effort and we believed that labor was not alone in needing war production posters. Our country needs a lot of hours of good hard ingenious brainwork from management.

And harder work in the office can set a better example for men in the plant—help curtail worker absenteeism, one of our serious national problems.

One more thing.

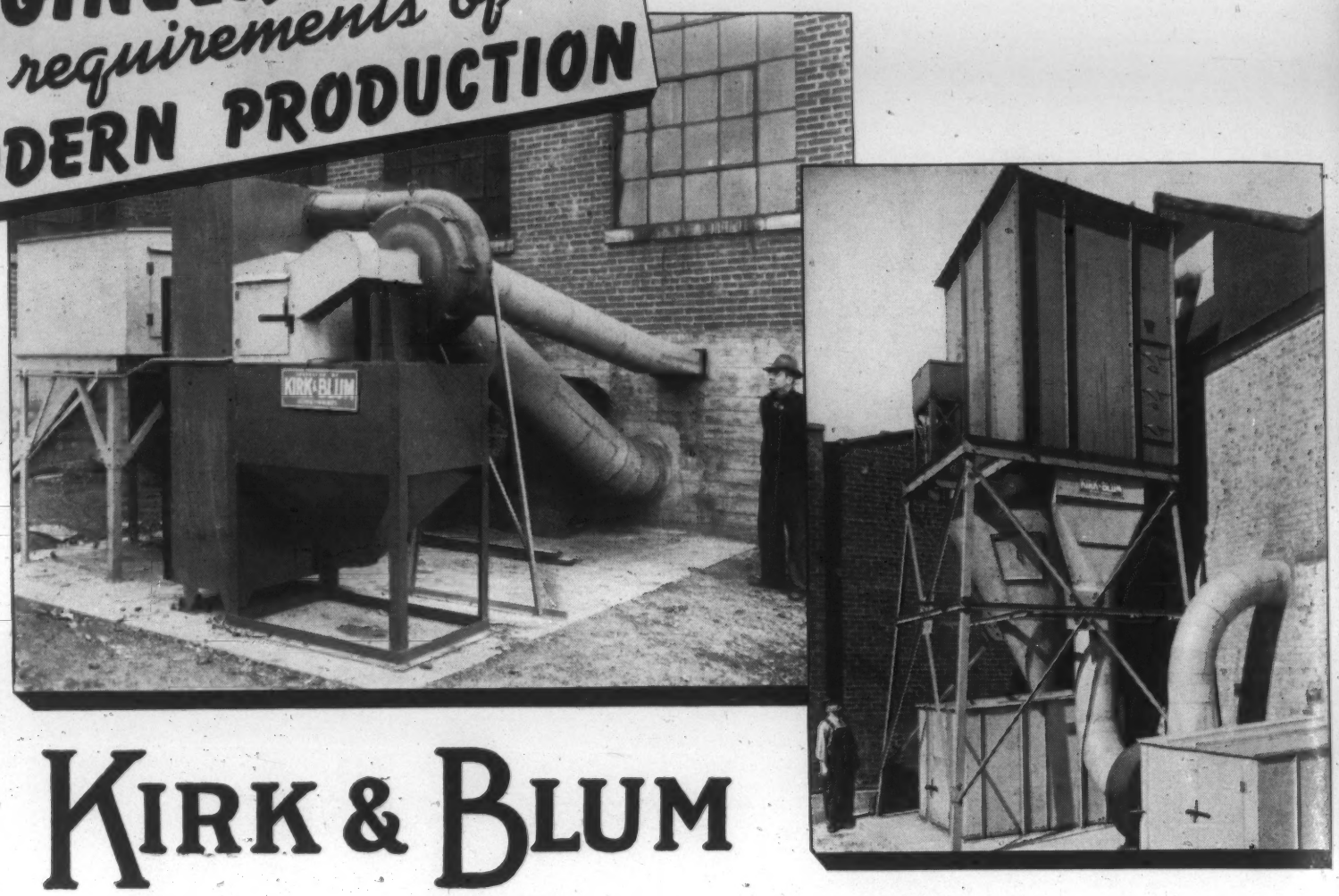
Heppenstall is in the business of forging steel and our engineers have had a lot of experience specifying tailor-made forgings of every size and shape from ship shafts to gear blanks and roll sleeves to crank pins. If your production requires the use of forged steel, maybe your present alloys can be changed to include less critical materials or maybe there's a chance to save through redesign. Ask us about it when you write for the posters.

Heppenstall Company, Pittsburgh, Pa.

This Advertisement Is Not
Pure Altruism

Our primary purpose, like yours, is to help our country win the war, but our secondary purpose is selfish. We want you to know us better. We have spent 53 years building our company to its present position in industry. We'd like to keep that position when the war is over.

ENGINEERED to the requirements of MODERN PRODUCTION



KIRK & BLUM

DUST CONTROL SYSTEMS

Are Doing Two Good Jobs for Leading Lathe Manufacturer

Our assignment for The R. K. LeBlond Machine Tool Co., was to eliminate the fine metal dust in castings grinding department, also the saw-dust and wood-shavings in the pattern shop. This called for the installation of two separate systems.

A Down-Draft System using Roto-Clones with specially designed "After Cleaner" made by American Air Filter Co. Inc., was installed in the castings grinding department. Metal-dust from grinders is exhausted through floor and bench gratings into under-the-floor ducts, saving much needed space.

In the pattern shop, a flat screen-type cloth filter with cyclone pre-cleaner is used as the dust collecting medium. Not only are the wood-shavings and saw-dust collected, but the air is returned to the building without heat loss, and dispersal of dust on adjoining property is avoided.

Send for any of the following Booklets:

- "Dust Collecting Systems in Metal Industries"
- "Fan Systems for Various Industries"
- "Blower Systems for Woodworking Plants"
- "Industrial Ovens"
- "Cooling Systems for the Glass Industry"
- "Data on Kirk & Blum Production Facilities"

In selecting different dust collecting media, we adhered firmly to the Kirk & Blum policy of making unbiased recommendations as to the best type for the individual job.

For efficiency and dependability in dust control—Consult Kirk & Blum.

THE KIRK & BLUM MANUFACTURING CO.
AN ORGANIZATION OF ENGINEERS AND MECHANICS
2852 SPRING GROVE AVE. CINCINNATI, OHIO

DURIRON PRODUCTS
In Anodizing Processes

A typical flow sheet showing Duriron equipment as used for anodizing aluminum airplane parts.

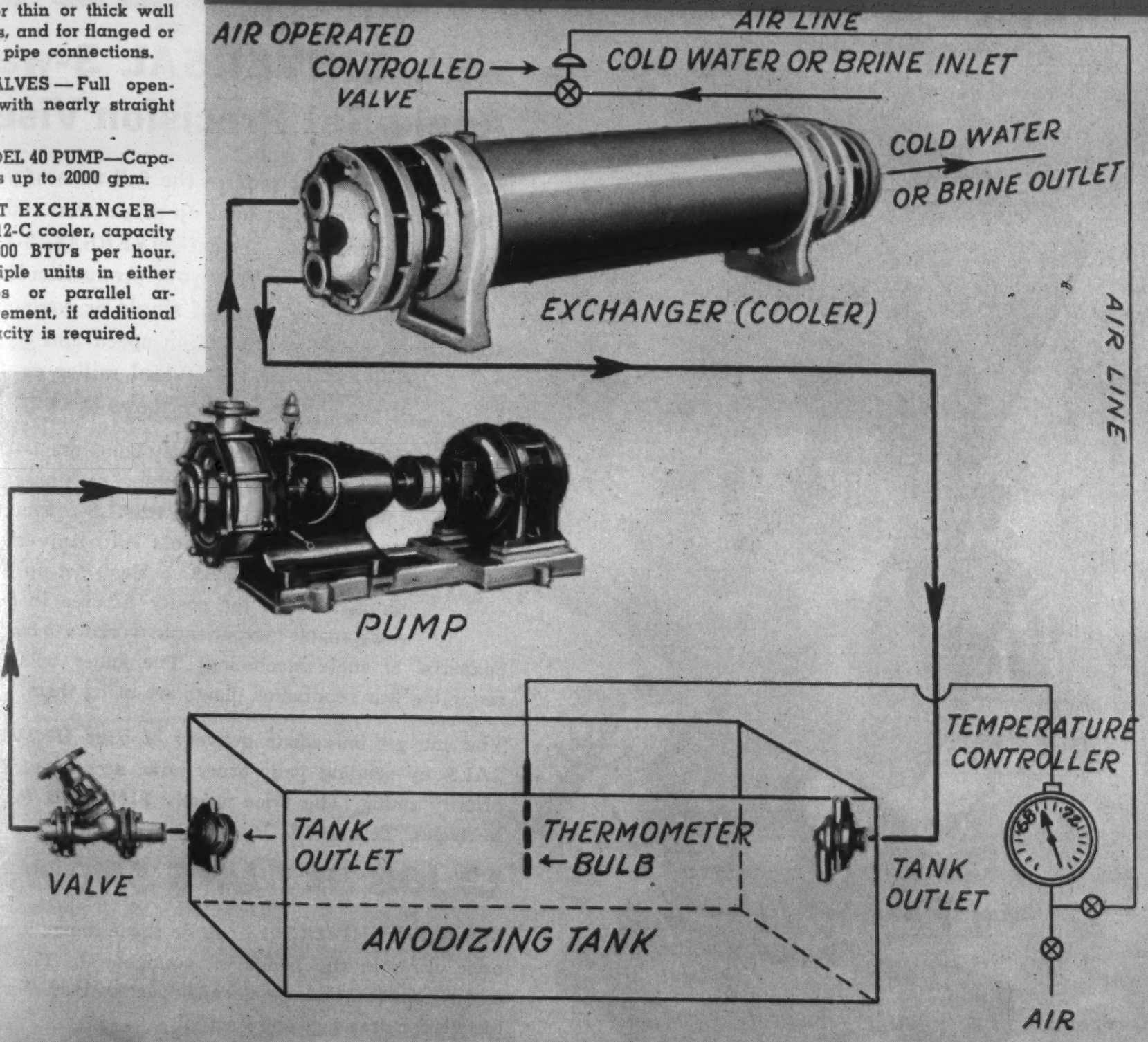
DURIRON EQUIPMENT USED

TANK OUTLETS—For either thin or thick wall tanks, and for flanged or lead pipe connections.

Y-VALVES—Full opening with nearly straight flow.

MODEL 40 PUMP—Capacities up to 2000 gpm.

HEAT EXCHANGER—No. 12-C cooler, capacity 300,000 BTU's per hour. Multiple units in either series or parallel arrangement, if additional capacity is required.



ARMY E NAVY

DURIRON · DURICHLOR · DURIMET · DURCO STAINLESS STEELS
CORROSION-RESISTING DURCO ALLOYS & EQUIPMENT
THE DURIRON CO. INC. DAYTON OHIO

ADVANTAGES OF DURIRON EQUIPMENT

There are some very definite advantages for the airplane parts manufacturer in the use of Duriron equipment.

1—Alloys are available which are completely resistant to either sulphuric or chromic acid types of anodizing solutions.

2—There is a saving of floor space because the efficiency of the equipment allows use of minimum size cooling units.

3—There is close temperature control, usually within one or two degrees.

4—Equipment for the most part requires less critical materials.

5—Prompt deliveries are assured if you will furnish reasonable preference rating.

THE DURIRON COMPANY, INC. DAYTON, OHIO

FREE FOLDER SHOWS HOW GREEN MEN CAN MACHINE ANGLE JOBS

with UNIVERSAL 3-way Angle-Set Precision Vises

Angle jobs need not require the full time of your highly trained men, or hold up production and tie up special machines. With UNIVERSAL 3-Way Angle-Set Precision Vises on your production lines, you can handle any kind of single or compound angle work at mass-production speed and cost—and put it on a standard miller or drill press! This free folder shows the way.

With their full three-way adjustment—360° rotation on base, 90° tilting on upper and lower cradles—UNIVERSALS convert old standard machine tools into universals! Further, UNIVERSALS slash set-up time, eliminate need for costly fixtures in angle work, enable inexperienced workers to become "experts" at angle machining! The folder tells how many big war production plants are using them.

You can get immediate delivery of your UNIVERSALS by sending your order now, accompanied by priority rating. The price is only $160 FOB Parma, Michigan. Terms: 2%, 10 days; net, 30 days.

12 JOB SET-UPS SHOWN!

SEE HOW UNIVERSALS can do these things in your own plant, in the hands of youngsters! This free folder gives complete details and specifications. Twelve installation drawings show actual production set-ups. Send the coupon for your copy today.

CLIP COUPON NOW!

UNIVERSAL VISE AND TOOL COMPANY
137 Main Street, Parma, Michigan

Rush free folder telling how Universals convert standard tools for angle work.
PLEASE PRINT:

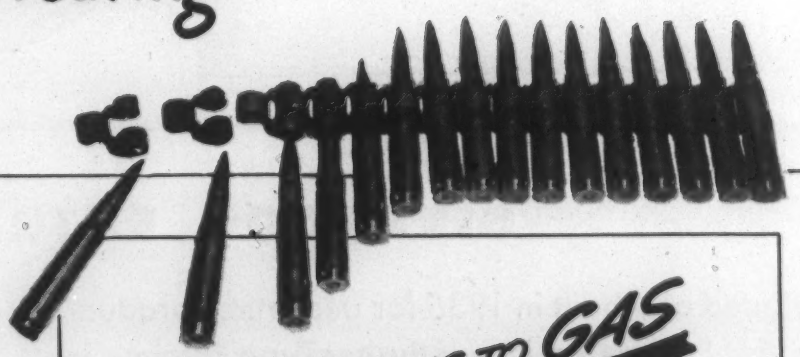
Name_____ Title_____

Plant_____

Address_____

Direct gas-heated continuous conveyor type hardening furnace for production of steel belt links.

To "keep 'em rolling" in the air calls for GAS heat-treating



THE TREND IS TO GAS

FOR ALL INDUSTRIAL HEATING

When an American fighter plane is maneuvered into the perfect spot to "let 'em have it," there can be no risk of a jammed machine gun or a parted cartridge belt. With so much depending on absolute workability of parts, small wonder the Army is so particular about specifications and proving tests on machine-gun metallic belt links.

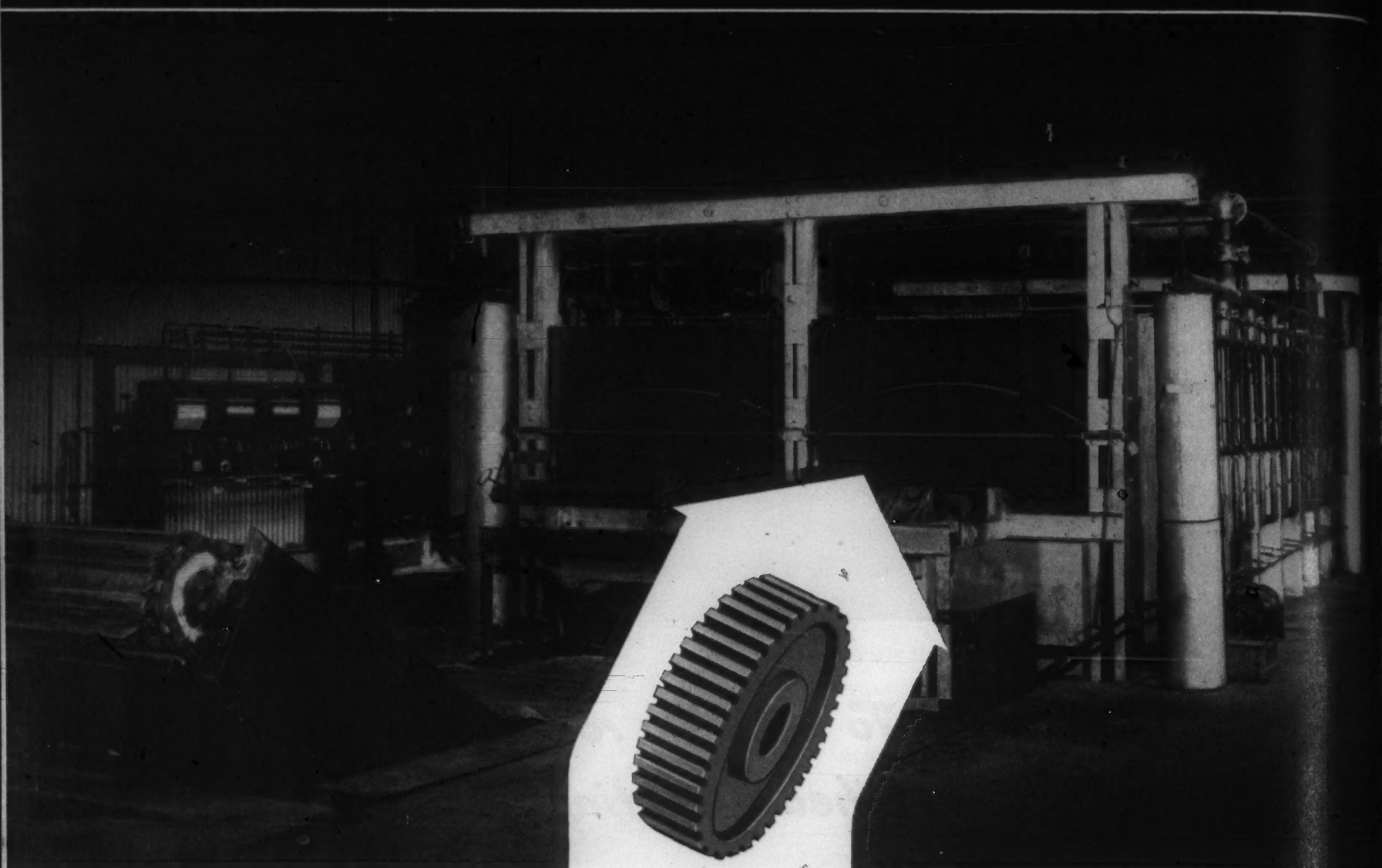
Ammunition is fed to a modern machine-gun by means of a continuous belt in which the shells act as pins to join the metallic belt links together as in the mill illustration above. At a firing rate of more than ten a second, the metallic link must fit not only the shell but the gun-firing mechanism as precisely as the shell itself. *Such precision calls for Gas heat-treating.*

This is only one of hundreds of Gas heat-treating operations carried on in America's industrial plants today . . . not only for parts for guns, planes and bombs, but for tanks, ships and many other munitions of war.

Call your Gas company if your plant has a heat-treating problem—or any problem involving the heating of metals for war production.

AMERICAN GAS ASSOCIATION
INDUSTRIAL AND COMMERCIAL GAS SECTION
420 LEXINGTON AVENUE, NEW YORK

INGENIOUS DESIGNING NETS SALEM CUSTOMER 2 MILLION POUNDS PER MONTH . . .



GIVES 30% EXTRA PRODUCTION

Designed and built in 1935 for peacetime production, this Salem Continuous Pusher Type Furnace is now meeting increased war production demands which are FAR in excess to the original requirements. The furnace has a double chamber — one for hardening small forgings or stampings, and another chamber for drawing, and both chambers can be used for normalizing. There is a common center wall to save heat loss. All firing is done on one side of each chamber, and due to the furnace design, excellent heat uniformity is provided. Scale is held to a minimum. ♦ One man feeds material into the hardening chamber. The parts are discharged from inside this chamber through a special chute which carries them onto a conveyor in the quench tank. The conveyor supplies another man with quenched parts which he places into the drawing chamber. This equipment, producing as much as 2 million pounds per month on various operations, nets our customer 30% higher production than he expected. And, remember, please, that during many years of this efficient production service, there have been no major repairs. Write Salem today for the answer to your heat treating problem.

SALEM ENGINEERING COMPANY

SALEM ENGINEERING CO. · SALEM, OHIO

By Their Deeds Shall You Know Them

Our fighting men, on whom the hope of human freedom depends, have already shown what they can do. We know how deadly they are in action. Yet this is a tough war. Those who know the Japs best tell us that we cannot win by maintaining the pressure and breaking the morale of the enemy, as we did in 1918. This is definitely a war of *destruction*. Our fighting men are equal to the job; but they deserve and will need the best armaments that American industry can turn out. We'll give them better fighting equipment than any enemy can produce.

Such is the spirit that motivates the endless shifts at Kropp Forge, as they turn out an ever-growing volume of dependable forged parts for America's planes, ships, ordnance, tanks and military vehicles. Every forging up to standard and a determined effort to produce every forging on time. It's our fighting men that we're really working for. Armament makers have learned that they can depend absolutely on Kropp Forge for the parts that must withstand the impacts and stresses of abusive service. Inquiries from ordnance builders are solicited.

Proudly we fly the Army and Navy "E" flag and stars, awarded and re-awarded for excellence and proficiency in the production of war material.

KROPP FORGE COMPANY

Makers of Drop, Upset and Hammer Forgings for Ships, Guns, Planes, Tanks, Ordnance and Machine Tools

"World's Largest Job Forging Shop"

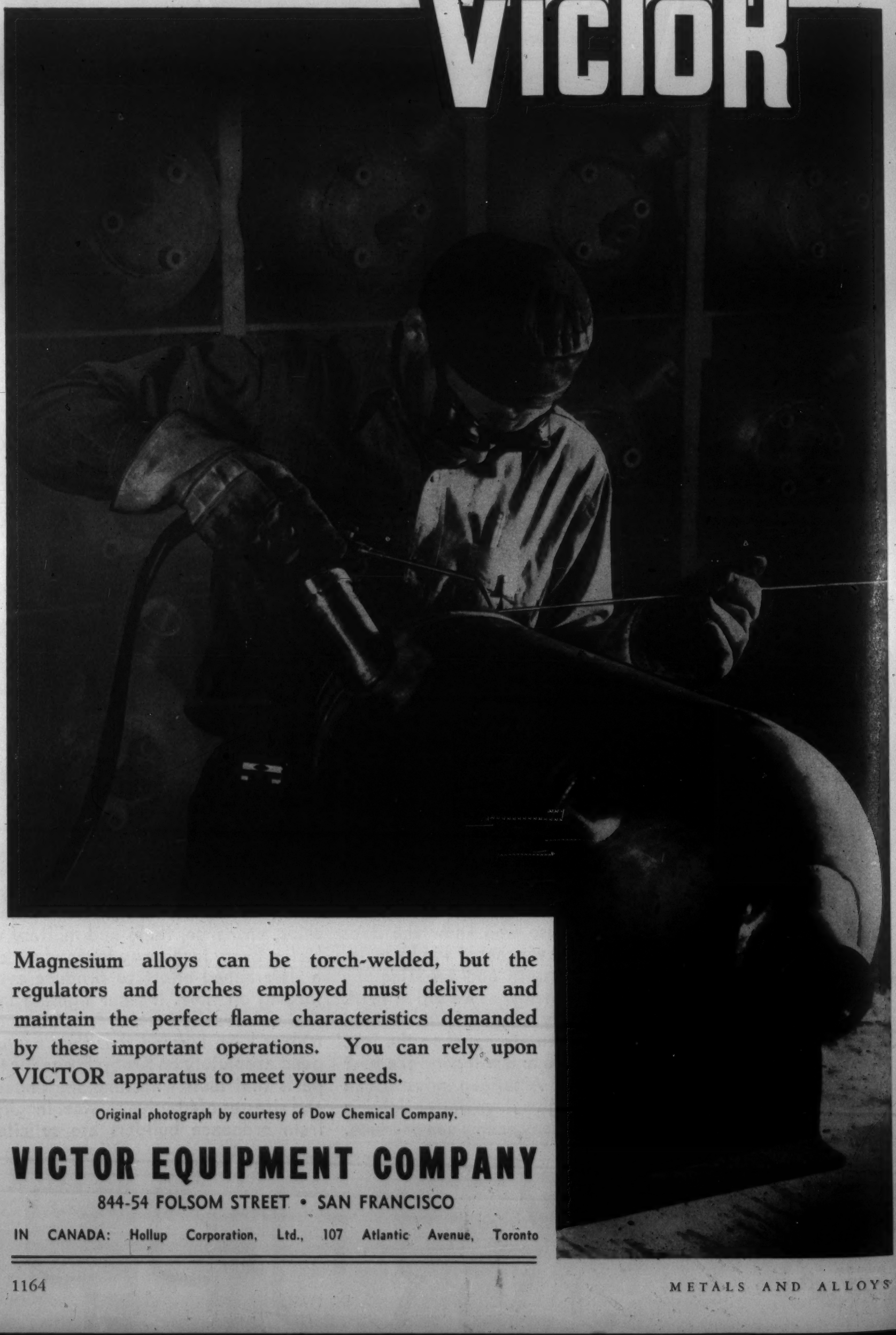
5301 W. Roosevelt Road
Chicago, Ill.

Engineering Representatives in Principal Cities

SERVING INDUSTRY SINCE 18 37
KROPP FORGE CO.
OVER 100 YEARS

KROPP

VICTOR



Magnesium alloys can be torch-welded, but the regulators and torches employed must deliver and maintain the perfect flame characteristics demanded by these important operations. You can rely upon VICTOR apparatus to meet your needs.

Original photograph by courtesy of Dow Chemical Company.

VICTOR EQUIPMENT COMPANY

844-54 FOLSOM STREET • SAN FRANCISCO

IN CANADA: Hollup Corporation, Ltd., 107 Atlantic Avenue, Toronto

LOOK OUT FOR "Bugs" THAT EAT STEEL

With everyone clamoring for steel, it's most disheartening to learn that a lowly sulphate reducing bacteria is consuming large quantities of industrial water cooling pipe.

It was hard for us to believe, too, but bacteriologists proved it to our satisfaction when they took sample water pipes and photomagnified one of these little "sulphur bugs" by fifty thousand diameters.

If you are having trouble with some "unexplainable corrosion" watch for:

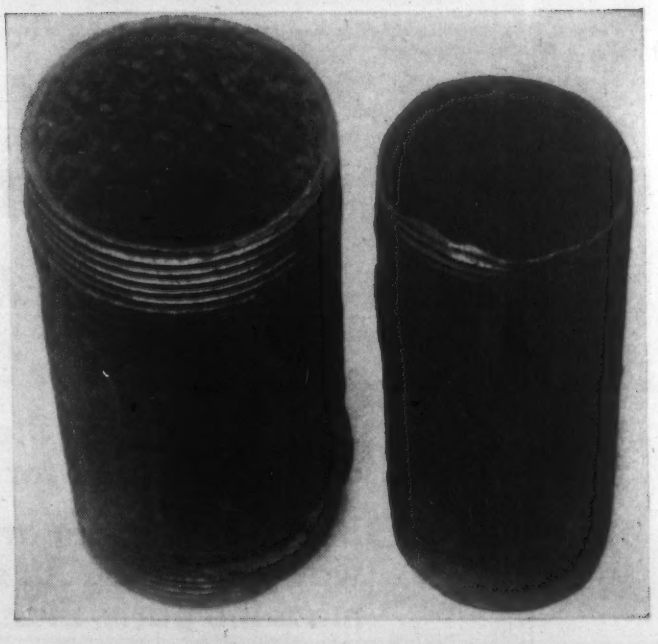
1. Free sulphur or sulphides on pipe sample even though water shows no signs of these.
2. Odor of H_2S in the exhaust cooling water.
3. H_2S when HCl is added to a sample of the corroded metal.
4. Progressively worse corrosion as you proceed farther from the inlet end.
5. Acceleration of corrosion rate.

These "bugs" are especially prevalent where water is taken from a well or stagnant pond. Chlorinate the water and you will kill the "bugs" and save many tons of badly needed steel. The Timken Roller Bearing Company, Canton, Ohio. Steel and Tube Division.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

ALLOY STEELS



Samples of pipe attacked by "sulphur bugs".

No, the photographer hasn't photographed his thumb. This is the portrait of a "sulphur bug" magnified 50,000 diameters.

... they too are
TOUGHENED
and Tempered

Furnace treated Steels . . . like battle-seasoned troops . . . are conditioned for hard service in any field of action.

B & L Bar Steels are assigned a front-line job in today's war production . . . speeding up output and making better machine parts, munitions and combat equipment.

These Cold Finished Steels are supplied as Annealed, Normalized, Spheroidized, or Strain Tempered Bars . . . giving increased toughness, ductility or machinability for special applications.

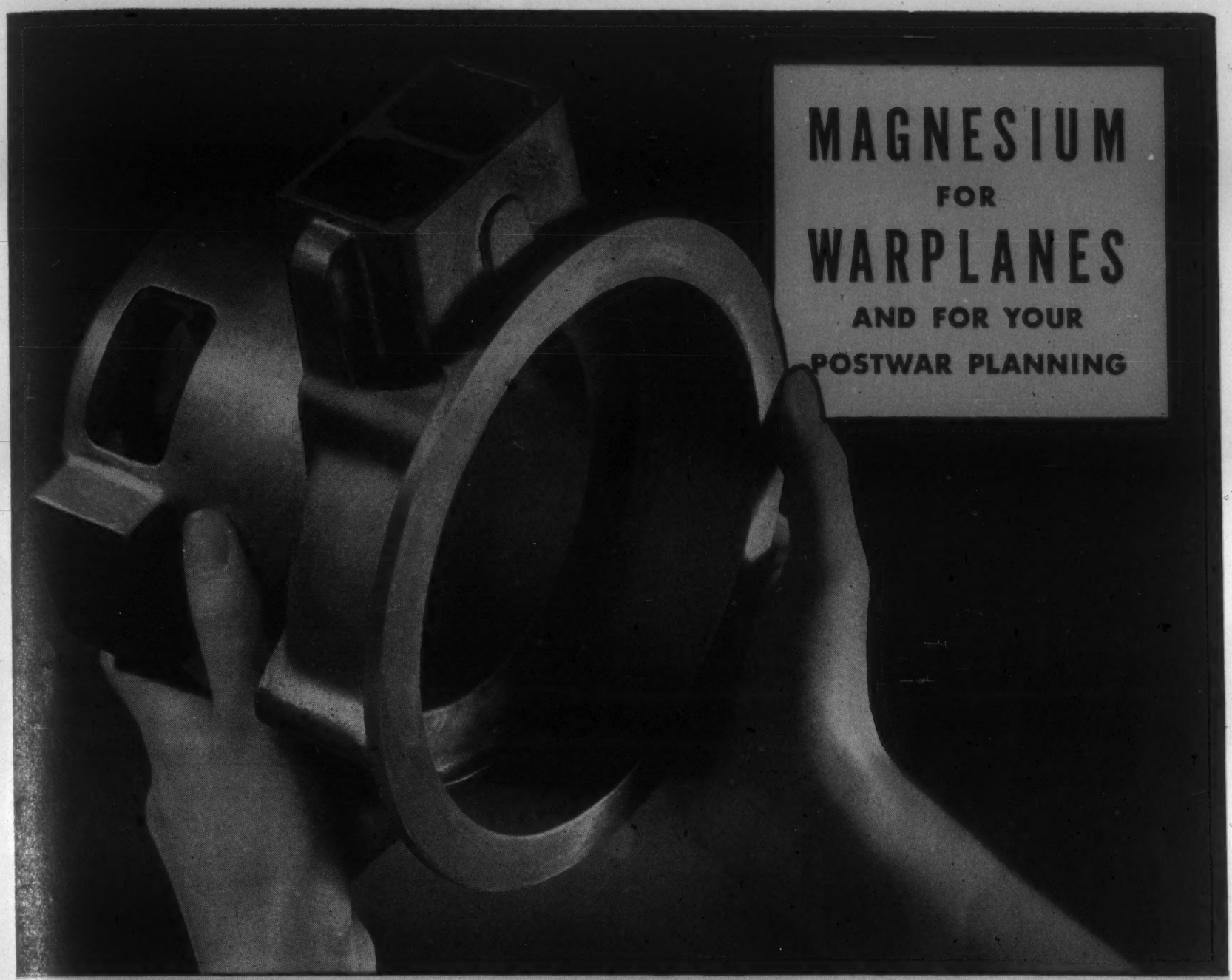
They help to solve many problems in fabricating operations, and simplify heat-treating the finished parts, thus saving valuable time in manufacture.

Utilize these advantages in your war production.

COLD DRAWN BARS • GROUND SHAFTING • SCREW STOCK • ANNEALED BARS • ALLOY STEELS

BLISS & LAUGHLIN, INC.

HARVEY, ILL. Sales Offices in all Principal Cities BUFFALO, N.Y.



This Mazlo Magnesium permanent-mold casting is an airplane starter-motor housing, one of many thousands made by American Magnesium Corporation. Magnesium contributes the lightness and high strength so necessary in aircraft; "Know-how" contributes the soundness and accuracy of detail that simplify and speed manufacturing.

Where parts are required in sufficient quantities, permanent-mold castings offer these advantages over sand castings: Surfaces are smoother and grain structures finer. Dimensional tolerances are closer, so castings can be lighter and need less machining. Costs of finished parts are usually less.

After the war, there will be a wealth of capacity to take care of your permanent-mold casting requirements—many times that of prewar industry.

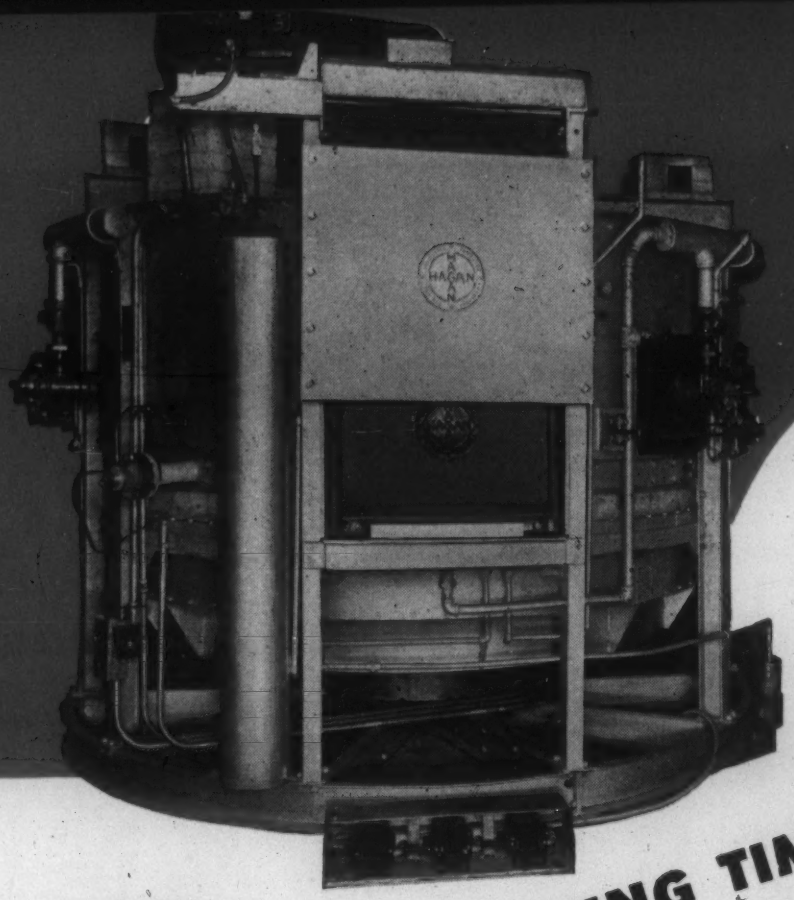
Magnesium alloys have casting characteristics peculiar to themselves, in addition to low specific gravity. This means that the methods of gating, chilling and coring, and how the metal is handled, all affect the quality of castings. That's where our experience can serve you best.

Twenty years of working with magnesium alloys have taught us *how*. American Magnesium engineers and plant men offer you that guidance. Sales Agent for Mazlo Magnesium Products: Aluminum Company of America, 1710 Gulf Building, Pittsburgh, Pa.

MAGNESIUM MAZLO PRODUCTS

AMERICAN MAGNESIUM CORPORATION

SUBSIDIARY OF ALUMINUM COMPANY OF AMERICA



Accurate Control of { HEATING TIME + TEMPERATURE + FURNACE DESIGN AND METHOD OF FIRING

...PROVIDES A CONTINUOUS SUPPLY OF UNIFORMLY HEATED BILLETS FROM 1"x 1" SECTION UP TO 10"x 10" IN

Hagan ROTARY HEARTH Forging Furnaces

Timed billet heating . . . controlled uniformity of heat saturation . . . maximum fuel efficiency and high production in minimum floor space, are just a few of the advantages users of Hagan Rotary Furnaces enjoy in these days of peak production.

Every billet must make a complete timed cycle of the furnace . . . emerges thoroughly soaked and constantly within the critical forging range! Burned or cold steel are entirely eliminated. Why not investigate this remarkable heating unit for your requirements?

GEORGE J. HAGAN COMPANY

PITTSBURGH, PA.

DETROIT CHICAGO LOS ANGELES SAN FRANCISCO

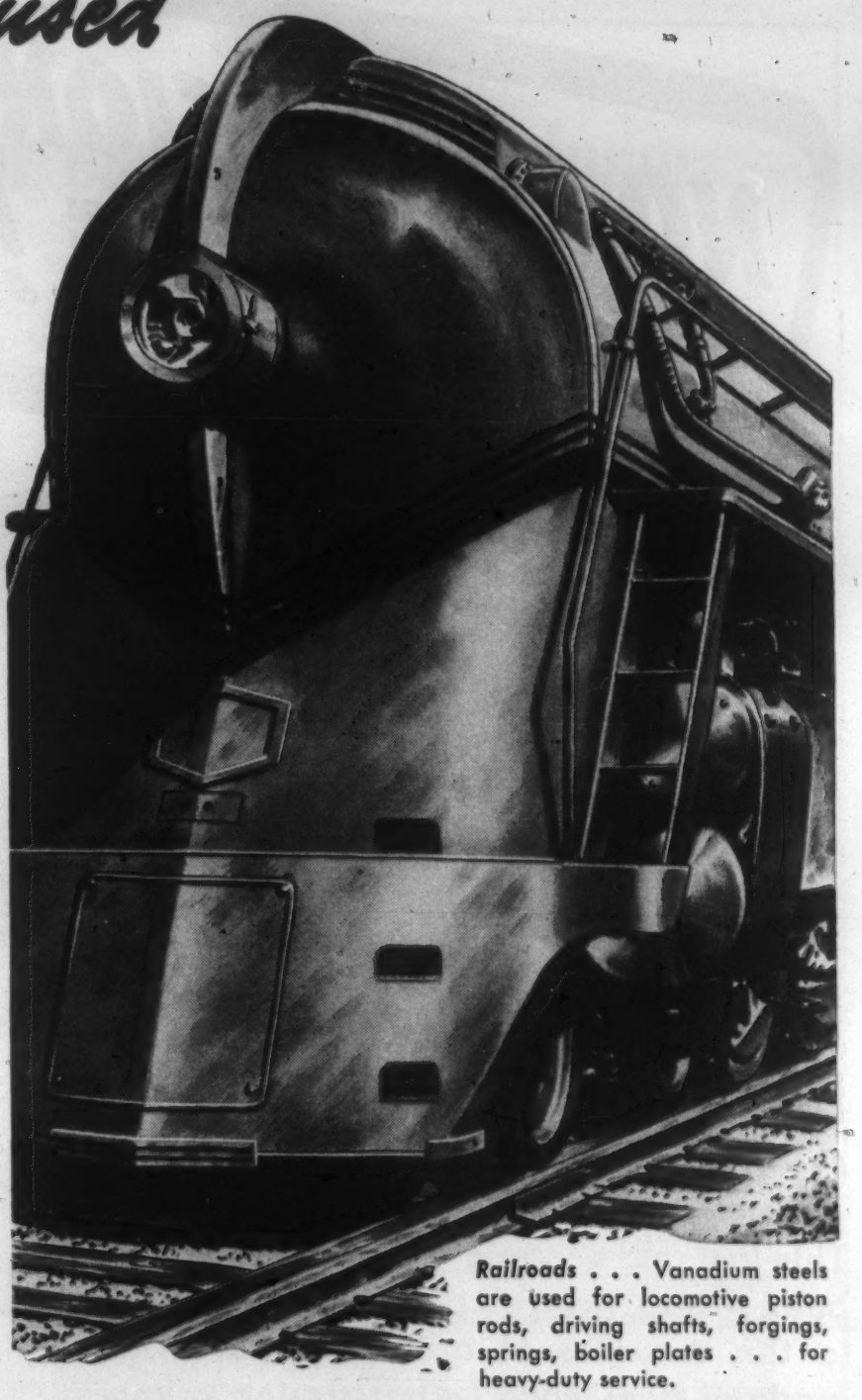
Why Vanadium is used in

ENGINEERING STEELS

Vanadium improves engineering steels by increasing their strength while maintaining their ductility. Vanadium-bearing steels are tough—resistant to abrasion, fatigue, and impact. They will deform rather than rupture under sudden overloads. This toughness is the result of a uniformly fine grain size imparted by vanadium to steel.

Vanadium steels are readily cast, forged, and rolled. They are easily machined; they have exceptional weldability. Vanadium . . . added in quantities ranging from .05 to .20 per cent, or roughly one to four pounds to a ton . . . simplifies the heat treatment of the steel. Its use results in a tough, strong, wear-resisting surface on case-carburized parts.

Besides vanadium, we produce other ferro-alloys and metals—such as chromium, silicon, manganese, tungsten, columbium, boron, calcium, and zirconium . . . used in making alloy steels. We do not make alloy steels, but we have over 35 years of experience with their development and use. If you have a problem in the selection or application of an alloy steel, call on us.

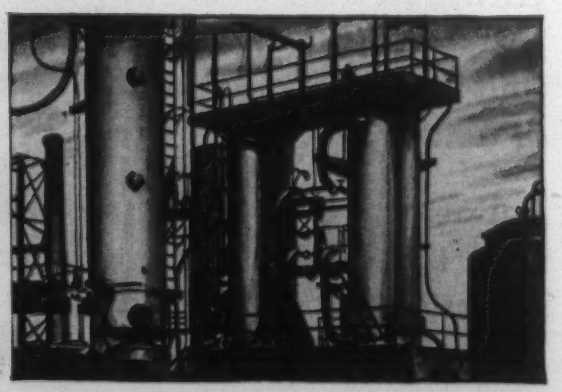


Railroads . . . Vanadium steels are used for locomotive piston rods, driving shafts, forgings, springs, boiler plates . . . for heavy-duty service.

BUY UNITED STATES WAR BONDS AND STAMPS

Tanks . . . Vanadium steels are used for armament and for engine parts, such as pistons, gears, axles, connecting rods, crank shafts . . . where strength and durability are life savers.

Mining . . . Drill bits, digging bars, wearing plates, winch shafts, and crank shafts for pneumatic machinery, are made of vanadium steels . . . for resistance to impact and wear.



Process Industries . . . Vanadium steels are used for turbine shafts, internal combustion engines, pressure vessels, superheater tubes, and steam valves . . . for toughness and durability.

ELECTRO METALLURGICAL COMPANY
Unit of Union Carbide and Carbon Corporation
30 East 42nd Street New York, N. Y.
In Canada: Electro Metallurgical Company of Canada, Limited, Welland, Ontario

Electromet
Trade Mark
Ferro-Alloys & Metals

Official U. S. Navy Photo

Protect Your Cartridge Cases, Primers, and Other Steel Parts with
EGYPTIAN CLEAR PHENOLIC BAKING VARNISH
Ordnance Dept. "Spec." AXS-736 Rev. 1.

This fast and economical special finish has been recently developed to give protection to the surfaces of ordnance parts now made of steel, such as percussion primers and the exterior and interior of shells and cartridge cases. Already it has passed the exacting tests of munition manufacturers and is standing up under the severe strains of actual service.

Following is a report we have received from the laboratory of a nationally known manufacturing concern*:—

"Mix—5 parts Varnish—1 part Reducer

Toluene	OK
Acetic Acid	OK
Ammonium Hydroxide	OK
Ethyl Alcohol	OK
Ethyl Ether	OK
Adherence	GOOD
Abrasion	OK
Salt Spray	OK

This material was applied and allowed to air dry 10 minutes after which it was baked at 350° for 30 minutes."

*Name on request.

For further information regarding this or other EGYPTIAN finishes contact Dept. MA.

THE EGYPTIAN LACQUER MANUFACTURING CO.
ROCKEFELLER CENTER—NEW YORK, N. Y.

EGYPTIAN FINISHES

EGYPTIAN
***Superior* FINISHES**

HANG ONE OF THESE CARDS IN YOUR SHOP

Tools for Machining Aluminum

FOR GENERAL MACHINE SHOP PRACTICE

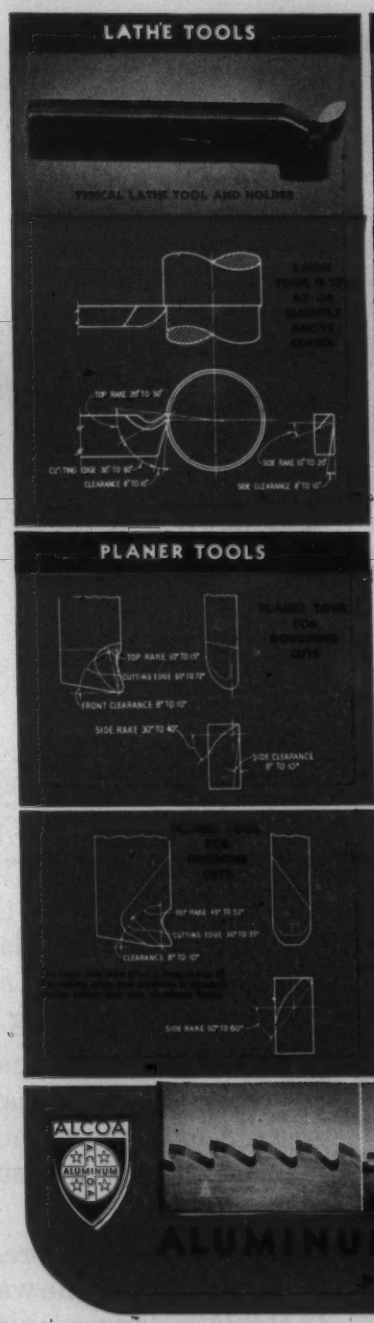
TOOLS for machining aluminum should generally have more top and side rake than is common for machining steel; the cutting edges should be keen and the tool surfaces should have a smooth, bright finish.

In the following illustrations, a wide range of rake angles is indicated. In general, the larger rake angles are employed for finishing tools and for the aluminum alloys that are not free-cutting; this includes the softer materials which require tools with exceptionally acute and keen cutting edges. On the other hand, rake angles in the lower range are used for roughing cuts and for machining the alloys that have free-cutting characteristics. Tools similar to those used for machining steel may often be employed successfully.

TOOL MATERIALS—High-carbon steels are good for many jobs where the cutting speed is low. High-speed tool steels are better for quantity production. Cemented-carbide-tipped tools are superior to high-speed tool steels, especially for aluminum alloys with a high silicon content.

CUTTING SPEEDS AND FEEDS—Generally, aluminum can be machined to best advantage by using the highest speed at which the equipment is capable of operating, with moderate feeds and cuts.

CUTTING COMPOUNDS—Use a copious amount of cutting compound. Soda water or soluble oil may be used for milling, drilling, and sawing operations. Mineral oil with the addition of 5 to 10 per cent fatty oil, such as lard oil, is an excellent lubricant. A 50-50 mixture of kerosene and lard oil gives excellent results.



The information printed on this large card (14″ x 20″) will answer many questions for machine operators, to whom the machining of aluminum is new. Use this coupon to send for a copy or write us on your company letterhead—

ALUMINUM COMPANY OF AMERICA
2162 Gulf Building, Pittsburgh, Pa.

Please send me your wall card on "Tools for Machining Aluminum."

NAME_____ TITLE_____

COMPANY_____

ADDRESS_____

TOWN_____ STATE_____

TO HIT 'EM H-A-R-D-E-R

THE year 1943 promises to be the grimmest, hardest year this country has ever faced. Every effort, and every dollar of national income not absolutely needed for existence, should go into war work and War Bonds.

In the Pay Roll Savings Plan, America finds a potent weapon for the winning of the war—and one of the soundest guarantees of the preservation of the American way of life!

Today about 30,000,000 wage earners, in 175,000 plants, are buying War Bonds at the rate of nearly half a billion dollars a month. *Great as this sum is, it is not enough!* For the more dollars made available now, the fewer the lives laid down on the bloody roads to Berlin and Tokio!

You've undoubtedly got a Pay Roll Savings Plan in your own plant. But how long is it since you last checked up on its progress? *If it now shows only about 10% of the gross payroll going into War Bonds, it needs jacking up!*

This is a *continuing* effort—and it needs *continual* attention and *continual* stimulation to get fullest results.

You can well afford to give this matter your close personal attention! The actual case histories of thousands of plants prove that the successful working out of a Pay Roll Savings Plan gives labor and management a common interest that almost inevitably results in better mutual understanding and better labor relations.

Minor misunderstandings and wage disputes become fewer. Production usually increases, and company spirit soars. And it goes without saying that workers with substantial savings are usually far more satisfied and more dependable.

And one thing more, these War Bonds are not only going to help win the war, they are also going to do much to close the dangerous inflationary gap, and help prevent post-war depression. The time and effort *you* now put in in selling War Bonds and teaching your workers to save, rather than to spend, will be richly repaid many times over—now and when the war is won.

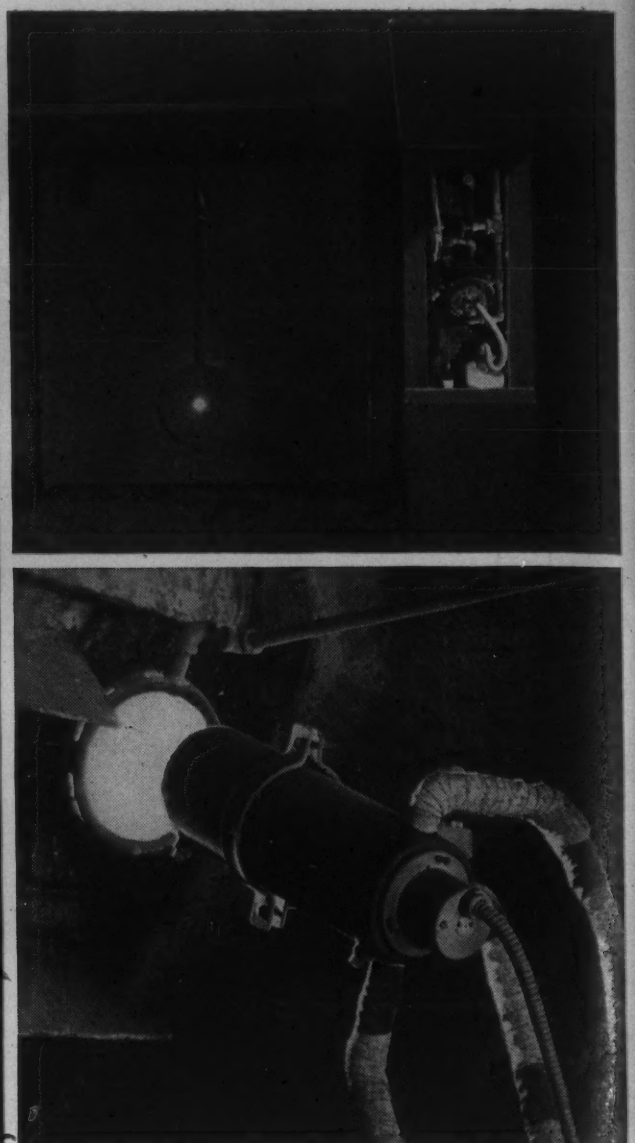
★ ★ ★

You've done your bit Now do your best!

This space is a contribution to victory today and sound business tomorrow by METALS AND ALLOYS

LIGHTER-WEIGHT CONTAINERS
FOR HIGH-PRESSURE GASES
WEIGHT saved on aviation equipment means more fire power, bigger cargo loads. So Kidde engineers have trimmed precious ounces from containers used for storing oxygen, carbon dioxide and other gases and liquids. These cylinders, though lighter, are built to withstand safely the high internal pressures to which they are subjected.
Walter Kidde & Company is "headquarters" for high pressure containers. Here you'll find cylinders in a variety of sizes and shapes, and release mechanisms of many types.
If you are storing high-pressure gases or liquids, let Kidde engineers help you get the right containers. Write to us today about your requirements.
Walter Kidde & Company
Incorporated
631 Main St., Belleville, N. J.
PROTECTS LIVES
Kidde
HIGH PRESSURE GASES • FIRE PROTECTION

First Helper in an open-hearth shop consulting a Micromax Roof Temperature Controller which cuts fuel down if roof overheats. The fuel-valve drive actuated by the Controller is the rectangular iron box on top of the pipes just behind the man.



Upper picture—Rayotube temperature detector for the Micromax at left, as installed between buckstays at furnace front . . . Lower picture—Rayotube can also look in at back of furnace.

MORE STEEL FROM O-H FURNACES?

Micromax Roof Temperature Control Can Help!

Important increases in the output of an open-hearth furnace usually follow the use of Micromax Roof Temperature Control, because:

1. Hearts are finished more quickly. The Helper sets the Controller for whatever roof temperature he considers safe; the Controller and its Rayotube then "watch" the roof continuously and hold a consistently higher temperature than the Helper could maintain, with safety.

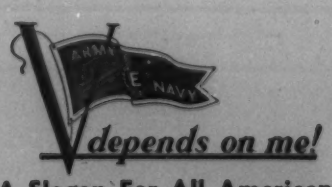
2. Furnace needs rebuilding less frequently because roof is not damaged by over-heating.

The Control equipment consists of Micromax Recording Controller, a Rayotube radiation-type temperature detector and a Micromax Electric Control valve drive unit, with its relay. The Micromax may be either the Strip-Chart, shown above, or a Round-Chart instrument.

The Rayotube may be placed at any one of three locations on the furnace. One is between the buckstays at the front of the furnace, and aimed, of course, at the furnace roof; this has the advantage of being convenient to the first Helper, and is especially recommended for tilting furnaces. Another location is at the back of the furnace, looking up at the roof. The third location is in the roof itself, looking down at a special refractory block set in the roof. Furnace type, construction and operating conditions determine location in all cases.

For a general description of Micromax Roof Temperature Controllers, see Bulletin N-33B-600B. If you have a definite application to a specific furnace, send us details and our engineers will make recommendations.

Jrl Ad N-33B-600B(1)



A Slogan For All Americans

LEEDS & NORTHRUP COMPANY, 4925 STENTON AVE., PHILA., PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS • TELEMETERS • AUTOMATIC CONTROLS • HEAT-TREATING FURNACES

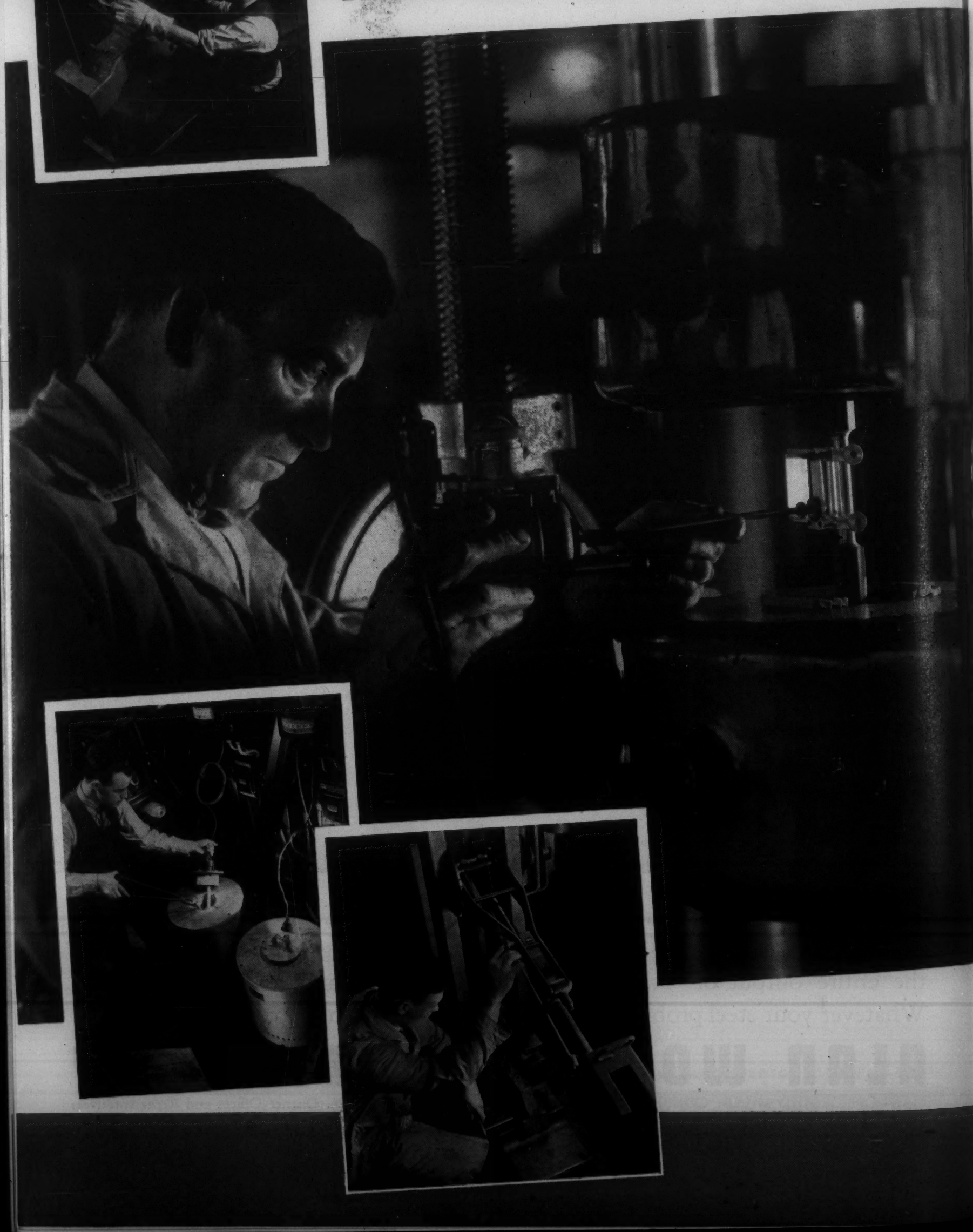
Five Ocean Fleet

Here is one step in the building of the "five ocean fleet." It shows the tapping of a heat for a steel made to U.S. Navy Department's rigid requirements. Today the entire output of "A. W." Quality Steels is allocated to war production. Whatever your steel problem may be, we will do everything possible to help you.

ALAN WOOD STEEL COMPANY

MAIN OFFICE AND MILLS: CONSHOHOCKEN, PENNSYLVANIA : SINCE 1826. District Offices and Representatives: Philadelphia, New York, Boston, Atlanta, Buffalo, Chicago, Cincinnati, Cleveland, Denver, Detroit, Houston, St. Paul, New Orleans, Pittsburgh, Roanoke, Sanford, N. C., St. Louis, Los Angeles, San Francisco, Seattle, Montreal.

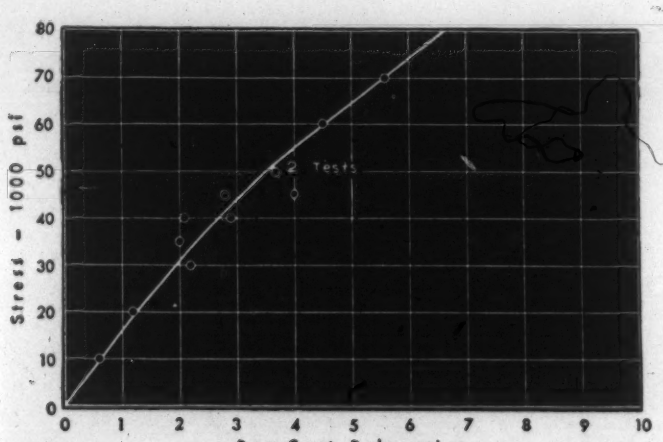
THEY'RE FITTING STEELS



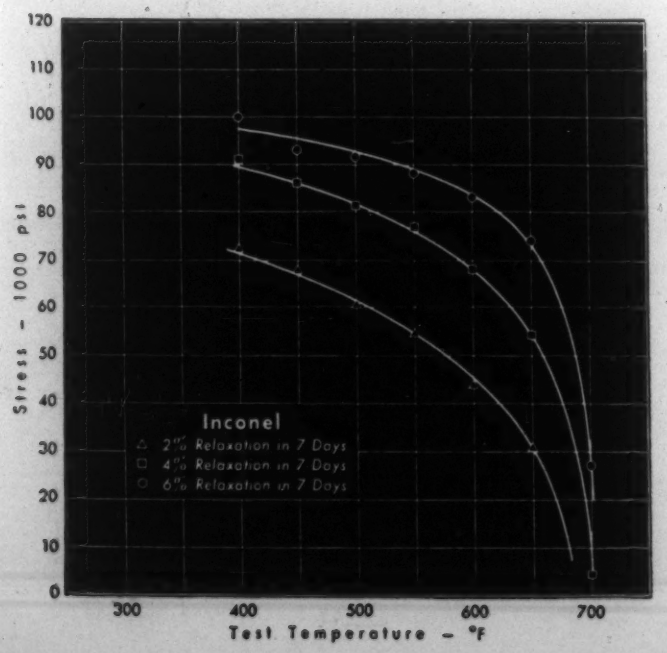
Inconel Springs Hold Load Loss to Minimum At Elevated Temperatures

At temperatures up to 650° F. and under high stress Inconel springs successfully resist relaxation or load loss. Above this point, Inconel still gives remarkable service, though stress must be lowered considerably and some relaxation tolerated.

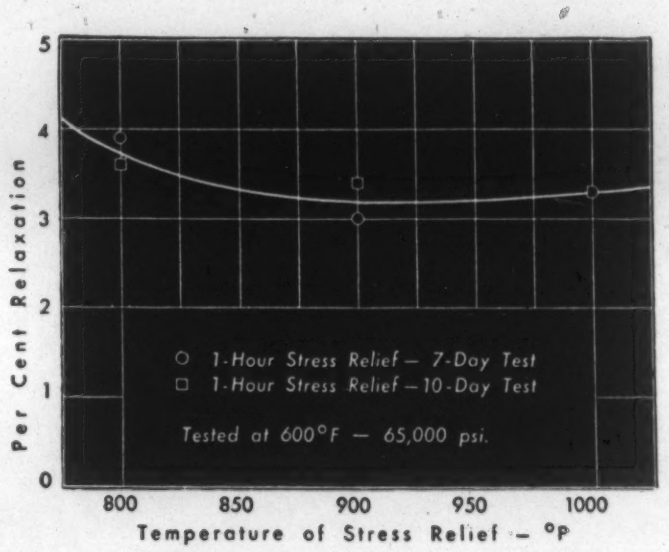
The following tests, made in cooperation with the A.S.M.E. Special Research Committee on Mechanical Springs, graphically show the unique properties of Inconel.



(1) Stress versus Relaxation in 7 days; Inconel at 650° F.



(2) Stress required to produce 2, 4 and 6 per cent relaxation of Inconel Springs in 7 days.



(3) Effect of Stress-equalizing Temperature upon the relaxation of Inconel Springs in 7 and 10 days. (Tests run at 600° F. and 65,000-psi stress.)

The springs tested were 1¼ in. OD, 2¾ in. free height and had 6¼ total coils. They were made of 0.148" diameter wire.

The graphs are based on behaviour of these springs loaded to a constant *height*. It is probable that, within stress and temperature limits which would produce not more than 10% relaxation, these results are also applicable to cases involving constant *load*.

Inconel Springs . . . helical, spiral or flat, of every shape and size . . . have high endurance limit, good strength, unusual stiffness. Inconel is immune to rust and highly resistant to oxidation and corrosion.

The bulletin "Relaxation Resistance of Nickel-Alloy Springs" reports the tests shown above and gives similar data on the relaxation resistance of Monel, "Z" Nickel and "K" Monel springs. This report also includes curves showing results of tests to determine the best stress-relief treatments for Monel and Inconel springs, and also curves and formulae showing changes in torsional modulus at high temperatures for each of these spring materials.

Copy of the bulletin and additional information on request. Write The International Nickel Company, Inc., 67 Wall Street, New York, N. Y.

★ ★ ★ ★ ★ **INCO NICKEL ALLOYS** ★ ★ ★ ★ ★

MONEL • "K" MONEL • "S" MONEL • "R" MONEL • "KR" MONEL • INCONEL • NICKEL • "Z" NICKEL

Sheet... Strip... Rod... Tubing... Wire... Castings

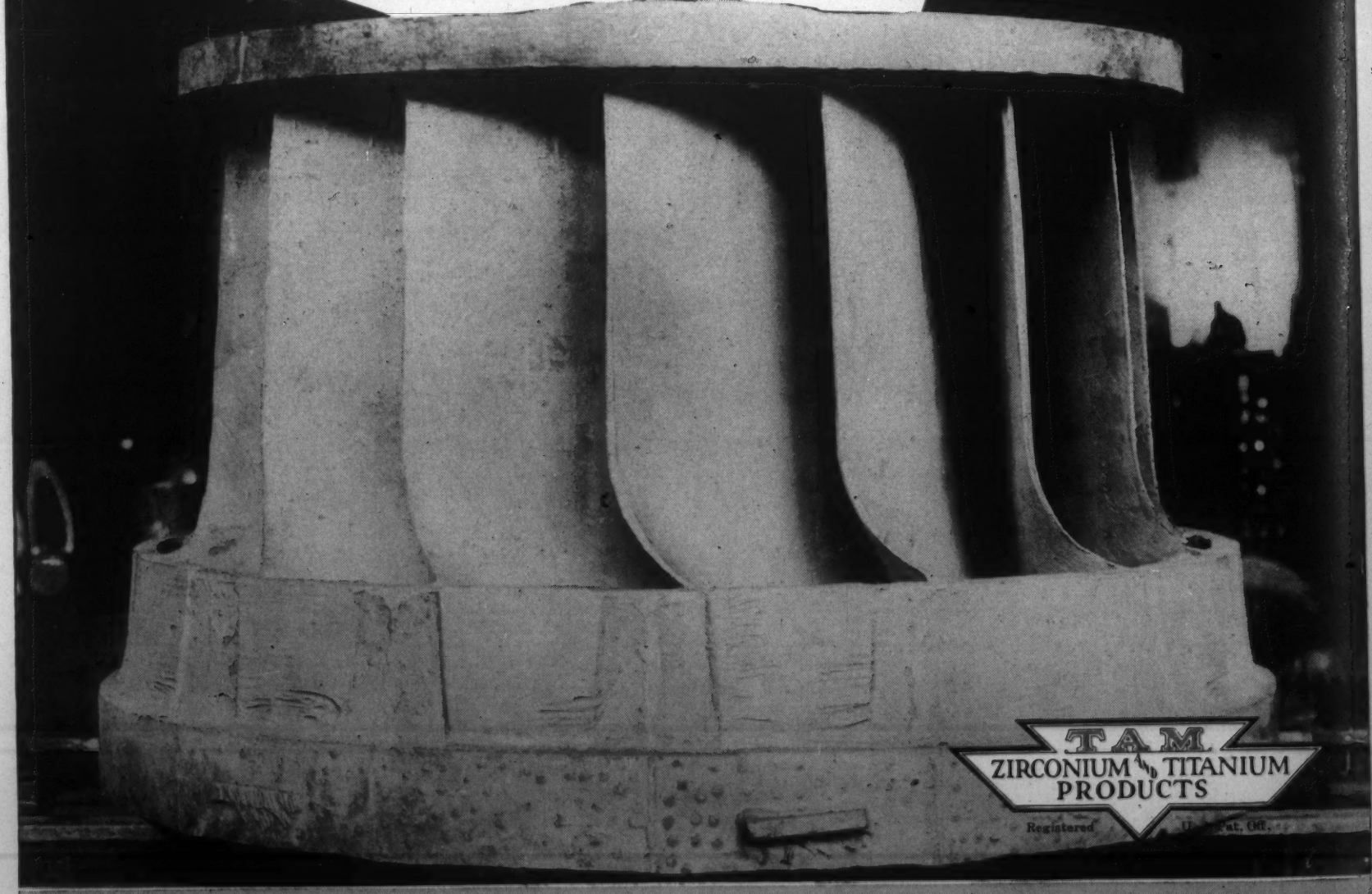
SMOOTH FACES FOR CASTINGS

TAM Zirconite super-refractory mold and core washes produce smoother surfaces and reduce cleaning costs

By resisting the burning-in of the molten metal, TAM Zirconite Mold and Core washes speed up output of good castings by reducing the number and time of cleaning and finishing operations. Available in three grades: Zirconite A has a melting point above 3775° F.; Zirconite B has a melting point above 3600° F.; and Zirconite C, for special uses, has a melting point above 3600° F. They are quickly mixed by adding to water, and can be applied by either spraying, swabbing or painting on cores and molds. Write for complete details, today.

TITANIUM ALLOY MANUFACTURING COMPANY

Zirconite Wash was used on this 94,000 pound .30-.35 carbon steel casting—11'6" high 14' diameter. Of special interest is the fact that no nails were used in the facing.



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EXECUTIVE OFFICES: 111 BROADWAY, NEW YORK CITY

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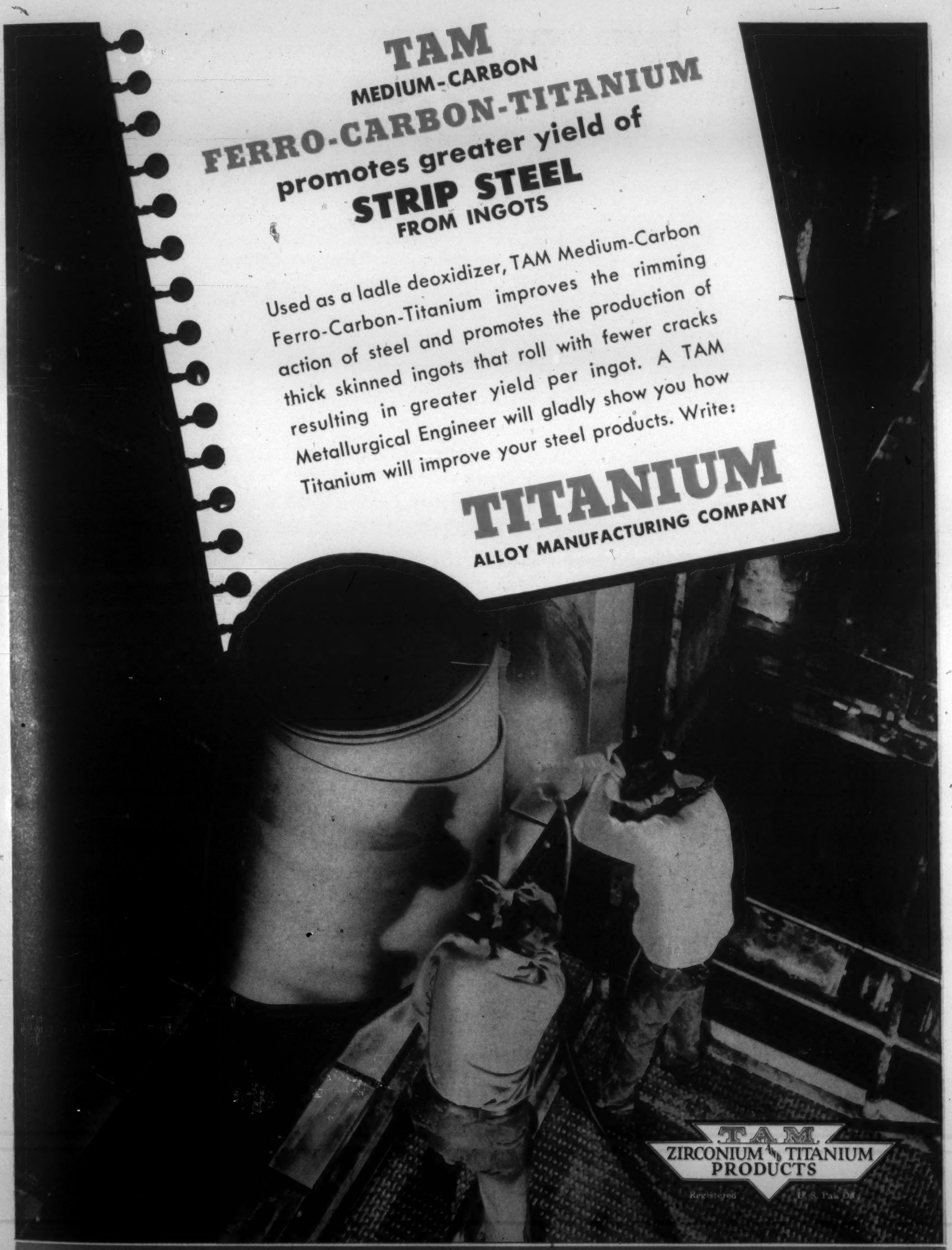
Representatives for Canada . RAILWAY & POWER ENG. CORP., Ltd., Toronto, Montreal, Hamilton, Winnipeg, Vancouver, Sydney
Representatives for Europe . . . . . T. ROWLANDS & CO., Ltd., 23-27 Broomhall St., Sheffield, England

TAM
MEDIUM-CARBON FERRO-CARBON-TITANIUM promotes greater yield of STRIP STEEL FROM INGOTS

Used as a ladle deoxidizer, TAM Medium-Carbon Ferro-Carbon-Titanium improves the rimming action of steel and promotes the production of thick skinned ingots that roll with fewer cracks resulting in greater yield per ingot. A TAM Metallurgical Engineer will gladly show you how Titanium will improve your steel products. Write:

TITANIUM
ALLOY MANUFACTURING COMPANY



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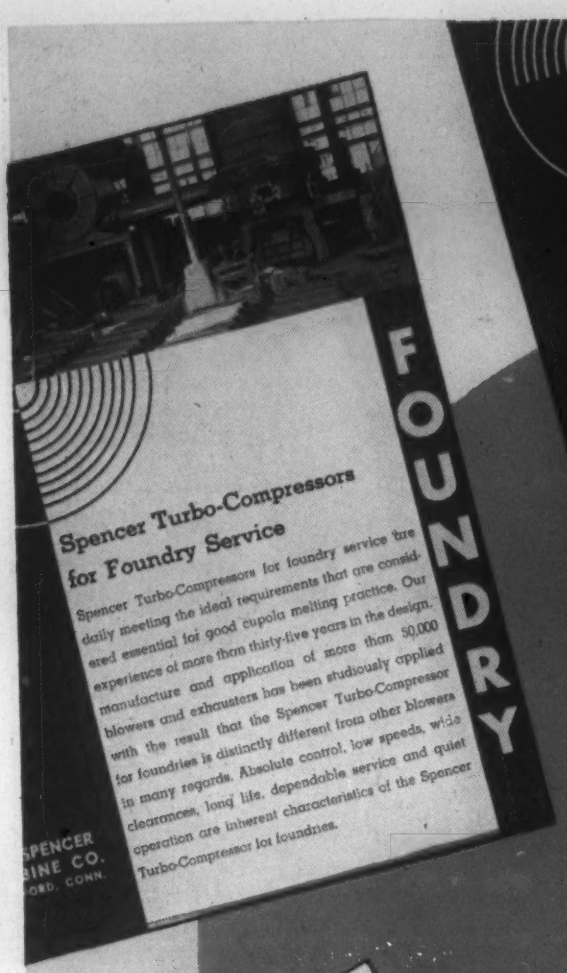
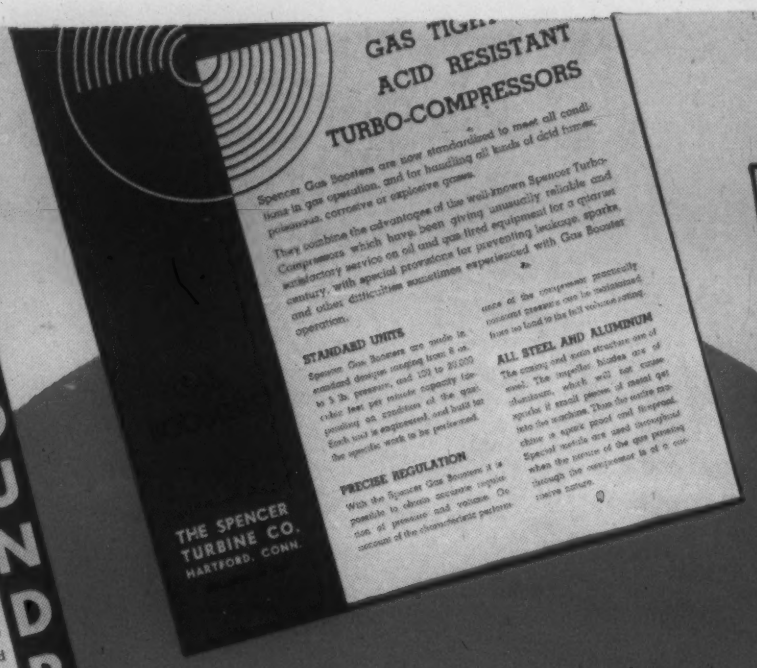
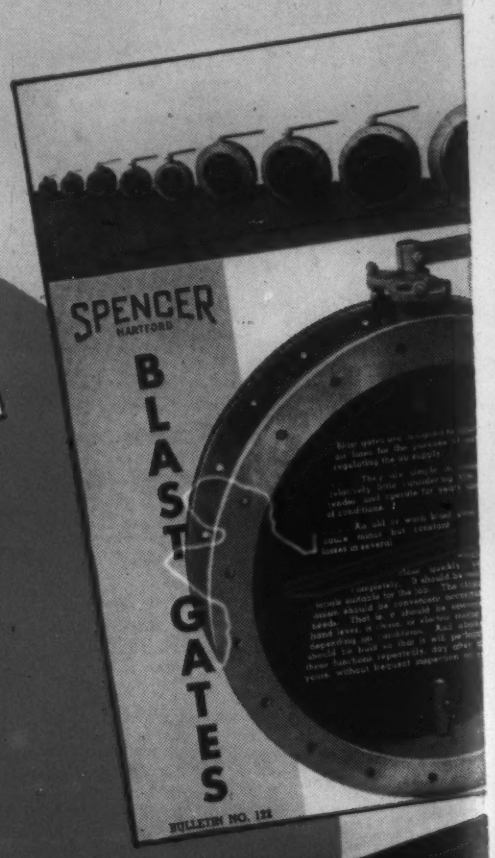
Representatives for Europe . . . . . T. ROWLANDS & CO., Ltd., 23-27 Broomhall St., Sheffield, England



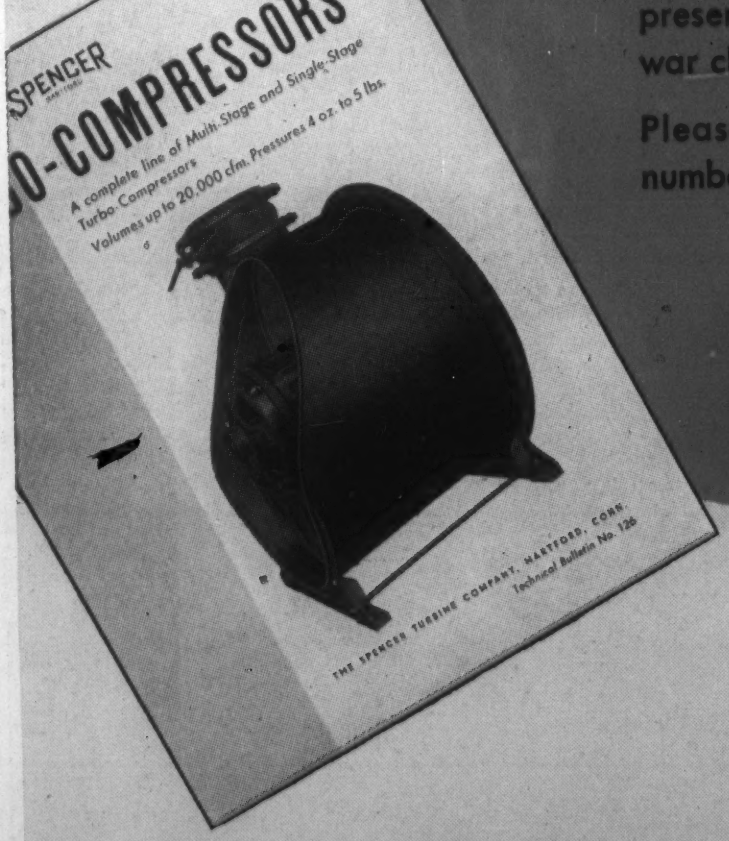


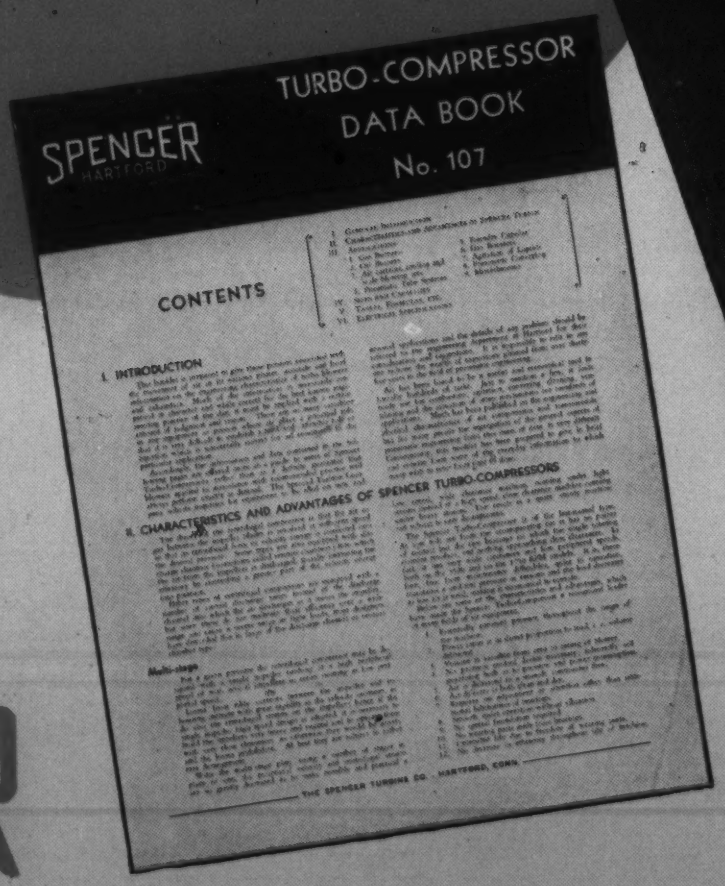


Because Spencer Turbo-Compressors are used in so many vital war industries, we again offer to send any or all of our many technical bulletins.

They will help you maintain your present equipment; improve your present set-up, or plan for post-war changes.

Please mention the bulletin numbers.





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TURBO-COMPRESSOR BULLETINS

THE SPENCER TURBINE COMPANY • HARTFORD, CONNECTICUT

TO HELP AMERICA MAKE HER *Victory Steel*

ON May 10th, production of Magnefer was begun at a new kiln plant, just completed under the direction of Basic Refractories, Inc., in behalf of Defense Plant Corporation. This new unit adjoins our burning plant at Maple Grove, Ohio. It supplements the Company's capacity for the manufacture of Magnefer, Syndolag and other clinkered dolomite products.

Basic Refractories' customers now are assured of ample supplies of Magnefer and Syndolag needed in the industry's war program, which calls for extra millions of tons of open hearth and electric steel.

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REFRACTORIES

BASIC REFRACTORIES, INCORPORATED

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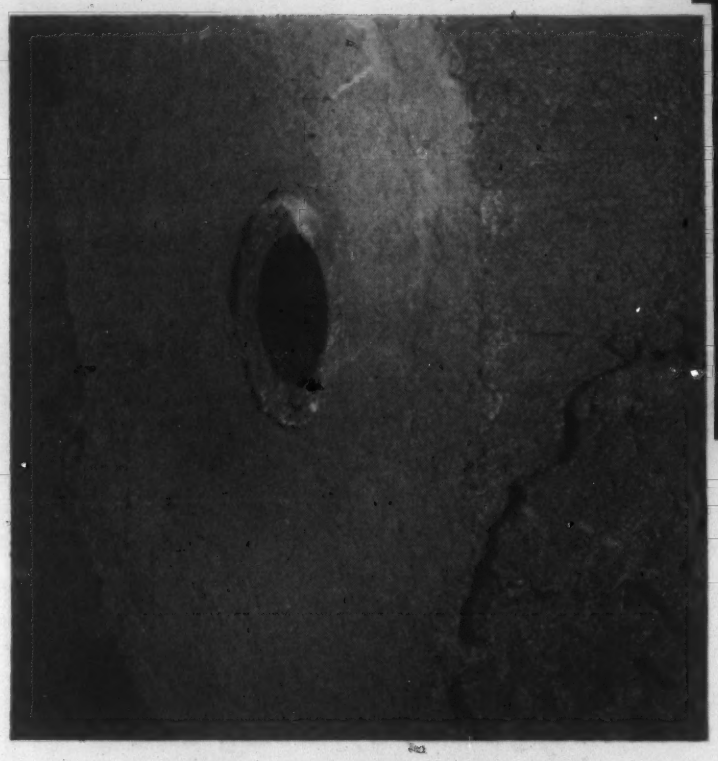
PRODUCERS OF MAGNESITE AND DOLOMITE HEARTH MATERIALS FOR STEEL FURNACES

DETROIT ELECTRIC FURNACES



END WALL IN CONICAL FURNACE PATCHED WITH P. B. SILLIMANITE No. 114 DRY PATCH.

●

Your copy of Bulletin No. 311 is ready. Complete data on P. B. SILLIMANITE for the Metallurgical Industries. Send for it today.

Keep 'Em Rocking With

P. B. SILLIMANITE

Detroit Electric furnaces which are lined with P. B. SILLIMANITE Brick and Special Shapes are setting new records for long life, efficient operation, lower refractory costs per ton of metal produced. Lining life may be extended by maintaining with one of the P. B. SILLIMANITE plastics and cements engineered for the job.

P. B. SILLIMANITE linings are endorsed by The Detroit Electric Furnace Division—The Kuhlman Electric Co.—and are made to their specifications. Linings for furnaces with Conical Shells are fitted to a gauge, assembled and match marked before shipment. Consequently, P. B. SILLIMANITE linings may be installed with a minimum delay.

COPPER and HIGH COPPER ALLOYS ● ALLOY IRON ● STEEL ● CUPRO NICKEL ● NICKEL and MONEL METAL ALLOY STEEL

TAYLOR P B SILLIMANITE

CHAS. TAYLOR SONS Co.

MANUFACTURERS OF REFRACTORIES • CINCINNATI • OHIO • U. S. A.

Advertisement

JUNE, 1943

COPPER ALLOY BULLETIN

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared Each Month by the Bridgeport Brass Co. "Bridgeport" *Headquarters for BRASS, BRONZE and COPPER*

Hot Forged Parts Display Superior Strength, Ductility

The hot forging process for the fabrication of non-ferrous parts has won increasing favor in recent years because of the superior physical properties resulting in the finished part. Compared with castings, hot forgings have greater strength, ductility, and impact resistance. They are generally tougher also, because of their freedom from the porosity found in many castings. The forging process tends to close up any voids which existed in the original cast billet, and the combined heating and working refines the grain structure, thus producing a tougher product.

Another feature in the growing popularity of hot forging has been the introduction of copper alloys characterized by exceptionally high mechanical strength in the hot forged conditions. Most of the copper alloys acquire their strength largely as a result of cold working. In such an alloy as Duronze III, however, the high mechanical strength is an inherent property rather than an artificially produced one. Duronze III is therefore particularly adaptable to the production of unusually strong parts by the hot forging process.

Memos on Brass—No. 39

Brass is one of the most useful of engineering materials because its physical properties can be varied over a wide range to meet the requirements of specific applications. These variations in properties can be effected by changing the copper-zinc ratio, by the addition of small quantities of other elements, or by mechanical means.

Annealing Step Important in Fabrication of Brass Goods

Selection of Correct Equipment Essential in Attaining Satisfactory Results and Maximum Economy of Operation

Use of the correct annealing equipment is a factor of primary importance in the fabrication of many types of brass goods. Each job usually presents an individual problem, and because of the many types of equipment available, and the considerations that influence their selection, fabricators frequently find it advantageous to consult the skilled technicians in Bridgeport's laboratories.

Up-to-date annealing furnaces, selected with a view to the job in hand, will be found, in the long run, to be more economical than the continued use of outmoded or inadequate equipment. Correctly selected equipment will pay for itself in reduced costs of operation and in the higher quality of product.

Factors Influencing Selection

Annealing equipment is not necessarily complex. Where requirements are small, a relatively simple type of manually operated furnace will usually suffice, provided it is equipped with a pyrometer for indicating the annealing temperature. The recording type of pyrometer is to be preferred, since it provides a record of the temperature of the annealing cycle.

Where annealing requirements are more extensive, the use of automatically controlled equipment is desirable. The most modern types of furnaces include equipment for performing a number of other operations besides the actual annealing.

Cleaning and Pickling

It should be kept in mind that work to be annealed should be free from drawing and lubricating solutions. Such work can be readily cleaned after annealing and pickling. On the other hand, work that is greasy before annealing will remain dirty and spotted after annealing and pickling.

For this reason, modern conveyor type furnace equipment is provided with a precleaning chamber which removes the drawing lubricant before the work enters the furnace proper. To conserve handling time and floor space, such furnaces are also equipped with quenching, acid pickling, washing, and drying chambers at the exit end. Equipment of this type is particularly well adapted for the manufacture of long runs of the same type of part, such as brass small arms and artillery ammunition.

Method of Firing

Small manually operated furnaces are generally gas-fired. Larger equipment may be gas- or oil-fired with automatic temperature controls. Electrically heated furnaces are also used in some localities. Whatever the source of heat, the work is brought up to the required temperature, and in the process becomes discolored through oxidation. This discoloration must be removed by cleaning with dilute sulphuric acid.

Bright annealing furnaces are also available for annealing copper, gilding metal, and commercial bronze without scaling. Here a controlled reducing atmosphere surrounds the metal during the annealing operation, and provision is made for cooling the metal down to room temperature without allowing it to become oxidized.

Local annealing, such as is required for softening the mouth of a brass cartridge case, is generally done by partly immersing the article to be annealed in a molten salt bath. For a stress relief heat treatment (to remove internal stresses resulting from cold working operations) finished cartridge cases

(Continued on Page 2, Column 2)

Laboratory tests on the corrosion resistance of copper alloys are constantly carried on at Bridgeport, supplementing field studies as a guide to the development of new and improved alloys to meet modern service requirements.

COPPER ALLOY BULLETIN

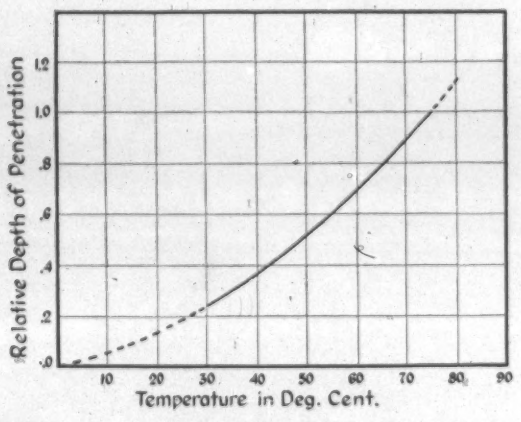
CAUSES OF CORROSION

This article, dealing with the influence of temperature, is the eighth of a series of discussions by C. L. Bulow, research chemist at Bridgeport Brass Company.

INFLUENCE OF TEMPERATURE

Before discussing the influence of water compositions upon the corrosion rate of metals, it will be well to recall that heat accelerates practically all of the reactions involved. Qualitatively, it may be said that a temperature rise of the corroding solution of about 20° C. will double the rate of corrosion. The effect of temperature is not always so pronounced, but in some cases it is even more so.

The change in corrosion rate with temperature generally depends on the nature of the corroding medium. The accompanying curve shows the relationship in the case of brass in a 3% NaCl solution.



Effect of temperature on rate of corrosion of brass in 3% NaCl solution

The influence of temperatures is one of the reasons that many power plant engineers keep a record of incoming and outgoing cooling waters in condenser installations, because it is recognized that a unit operating at too high a temperature may fail prematurely. The higher temperatures of cooling waters during the summer is also one of the factors contributing to more rapid summer corrosion.

Instances have been reported in which new condenser tubes installed during the winter season have given longer service than tubes installed in summer. This difference in performance occurs because of the type of protective film which forms. The corrosive film which forms on a metal in cold water is generally thinner and more continuous than one which forms in warm water. In warm and hot water the susceptibility toward pitting generally increases substantially. As a result of pitting, th useful life of a condenser tube may be considerably shorter than that indicated by th over-all corrosion rate, as evaluated by loss in weight or in tensile strength.

On the other hand, an increase in temperature may lead to the precipitation of calcium carbonate and other types of scales on the metal surface. These scales, when continuous, often confer consider able protection on the underlying metal. This scale formation is due to the decrease in solubility of certain minerals in the water with increase in temperature.

Bulletin Index for 1942 Now Available

A complete index of all articles which appeared in the COPPER ALLOY BULLETIN during 1942 is now ready for distribution to readers. The index is thoroughly cross-referenced to facilitate its use, and includes a complete listing of all items which appeared in the New Developments column.

Copies of the index may be obtained free of charge by writing Bridgeport Brass Company on your company letterhead.

Annealing Equipment

(*Continued from Page 1, Column 3*)

are also completely immersed in molten salt. Stress relief heat treatments can also be carried out in special continuous recirculating gas-fired furnaces.

It will be seen that the correct selection of furnace equipment depends on many factors: operations involved, length of production runs, continuous or intermittent use, composition of alloys. Bridgeport metallurgists will aid fabricators in weighing all of these factors.

Preventing Hot Breaks

"Hot breaks" in brass—intercrystalline cracks resulting from a combination of heat and stress—can be prevented by observing simple precautions. A detailed explanation of the causes and prevention of hot breaks was given in the January, 1941, issue of the COPPER ALLOY BULLETIN, copies of which may be obtained from Bridgeport.

NEW DEVELOPMENTS

This column lists items manufactured or developed by many different sources. None of these items has been tested or is endorsed by the Bridgeport Brass Company. We will gladly refer readers to the manufacturer or other sources for further information.

A thread milling machine is described as especially suitable for threading operations on the nose of 75 mm. shells. It is equipped with an air-operated chuck of capacity up to 3 inches in diameter, and all driving elements, electrical controls, and coolant system are enclosed in a rugged structure. **(No. 450)**

A new connector is designed to serve as a substitute for soldered and taped joints in electrical wiring, according to the manufacturer. Connectors are said to use no rubber, tin, or lead, and to provide a satisfactory joint both electrically and mechanically. It is said that the insulation on the connector will not puncture at 10,000 volts. **(No. 451)**

A vernier height gage is made in three sizes of 12, 18, and 24 inches and is available in metric as well as in English measure. It is saic to be designed particularly for use in jig and fixture making and for general layout and inspection work. It is described as a valuable adjunct to gage blocks in angular measurements and other operations where a high degree of accuracy is necessary. **(No. 452)**

Hole saws of fine-tooth design, said to be suitable for working on non-ferrous sheet, are made in a range of sizes from ⅜ to 4 inches. Sizes are in steps of 1/32 inch up to 2 inches, then 1/16 inch up to 3 inches, and ⅛ inch up to the maximum of 4 inches. **(No. 453)**

A forming machine is reported to be capable of rolling edge forms on both sides of a flat sheet in a single pass. Assembly is available to specification as to sheet width. One model will handle thicknesses to 22 gage, another to 16 gage. A variety of edge forms can be produced, and the manufacturer is prepared to furnish the proper rolls for a specific job. **(No. 454)**

A new polishing lathe is provided with a clearance hole through the entire machine. This feature, according to the manufacturer, permits polishing a portion of a long piece of work up to the maximum capacity of the lathe. Work can be loaded and unloaded while the spindle is in rotation, and a switch and mechanical brake control are provided to facilitate handling of work which can be loaded better when the spindle is stationary. **(No. 455)**

Metal hammers for machine shop and assembly line work are being produced with light or heavy heads. Construction consists of a cast bronze head with a hickory handle. Weight of heads ranges from 5 ounces to 8 pounds. **(No. 456)**

PRODUCTS OF THE BRIDGEPORT BRASS COMPANY

Executive Offices: BRIDGEPORT, CONN.—Branch Offices and Warehouses in Principal Cities

SHEETS, ROLLS, STRIPS—*Brass, bronze, copper, Duronze,* for stamping, deep drawing, forming and spinning.

CONDENSER, HEAT EXCHANGER, SUGAR TUBES—For steam surface condensers, heat exchangers, oil refineries, and process industries.

PHONO-ELECTRIC* ALLOYS—High-strength bronze trolley, messenger wire and cable.

WELDING ROD—For repairing cast iron and steel, fabricating silicon bronze tanks.

LEDRITE* ROD—For making automatic screw machine products.

"Bridgeport" BRASS CO.

COPPER WATER TUBE—For plumbing, heating, underground piping.

DURONZE ALLOYS—High-strength silicon bronzes for corrosion-resistant connectors, marine hardware; *hot rolled sheets* for tanks, boilers, heaters, flues, ducts, flashings.

BRASS, BRONZE, DURONZE WIRE—For cap and machine screws, wood screws, rivets, bolts, nuts.

FABRICATING SERVICE DEPT.—Engineering staff, special equipment for making parts or complete items.

BRASS AND COPPER PIPE—"Plumrite"* for plumbing, underground and industrial services.

Established 1865

BRIDGEPORT BRASS

Note: Bridgeport products are supplied in accordance with existing priority regulations.

*Trade-name.

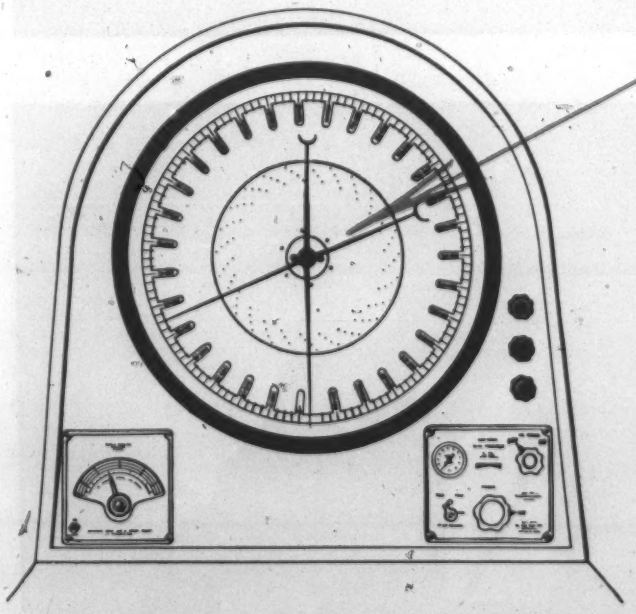
Number 2 of a series covering use and maintenance of Southwark Testing Machines

War Service Memo: To users of Southwark testing machines

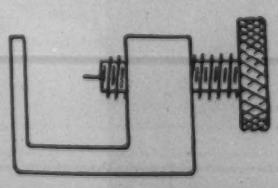
the proper positioning of

Indicating Hands

The extremely sensitive and accurate Southwark-Tate-Emery Indicator operates as a mechanical potentiometer using air for power. When the air pressure is off and the indicator at rest, the black hand should point directly downward. If because of shock or any other reason it does not, it should be removed and corrected.



Use the hand jack (illustrated), furnished with the machine, to remove it. In replacing it in the proper position (over the letter "T" in the space between the ends of the scale) the hand should be firmly driven on the tapered shaft using a short squared end tube which is tapped sharply with a light wrench.

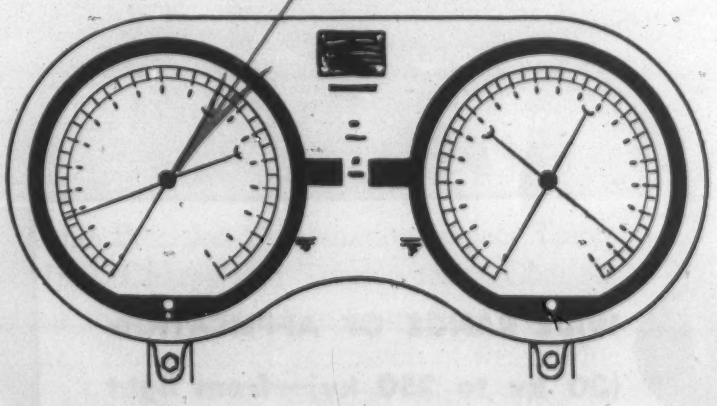


If this simple precaution is taken, there should never be any difficulty in setting to "O" by means of the normal adjustments.

It is extremely rare that the red maximum hand requires adjustment. If it should become necessary, however, the hand should be disassembled and the spring washer bent very slightly as required.

Hundreds of Southwark machines with bourdon tube gages are still in service. With normal no-load conditions, the black indicating hand and the rotatable dial of these bourdon tube gages should be in about the position shown. If not, it should be positioned properly following the same procedure in removing and replacing hand as described above.

The red "max" hand of these bourdon tube gages has no friction washer. The proper friction is produced by the

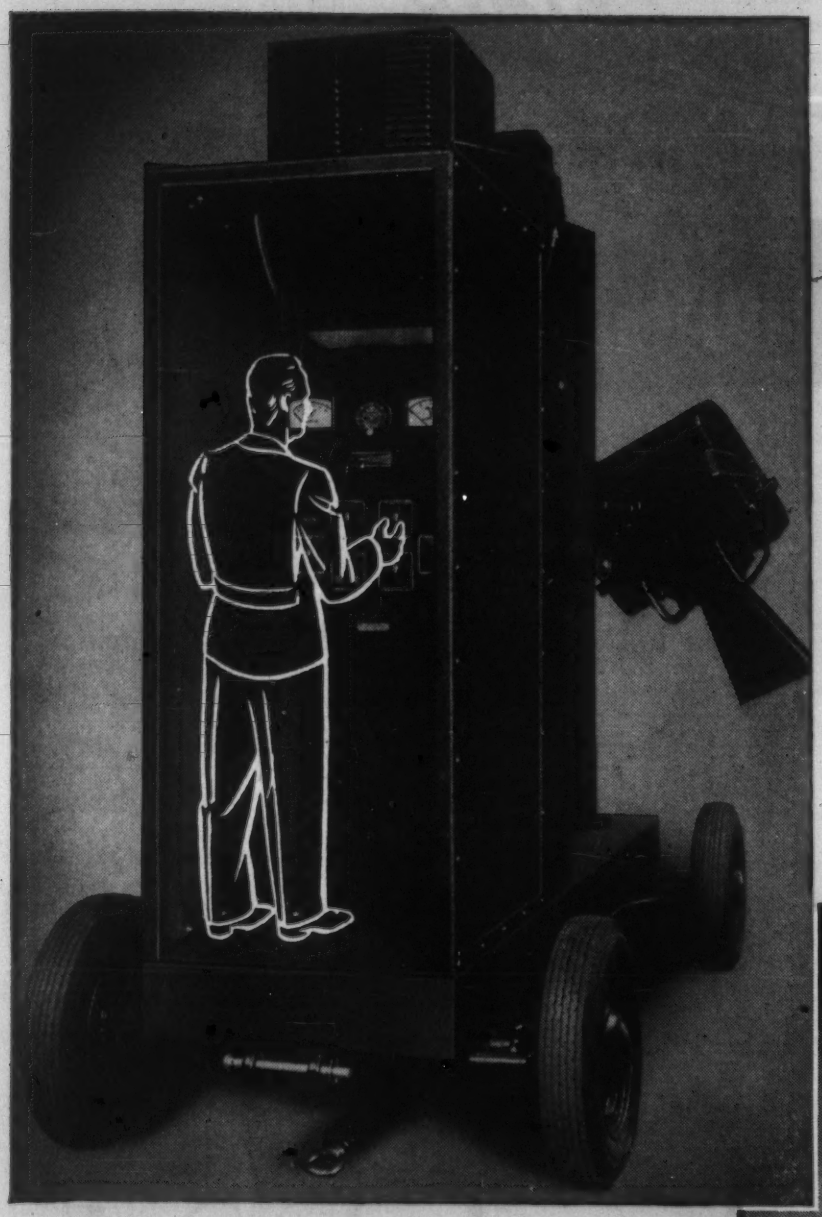


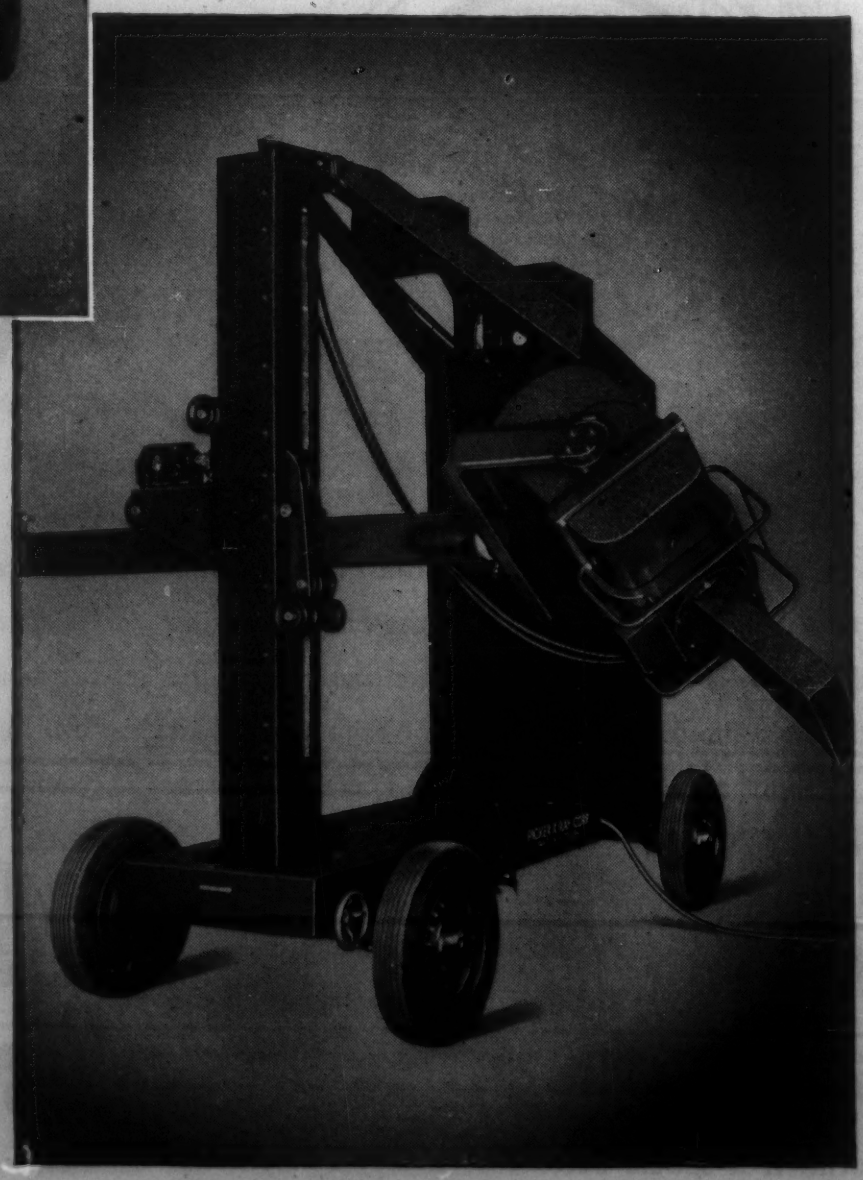
lubricant used on the shaft. Vaseline at the center of the shaft is used for maximum friction, a mixture of vaseline and oil for less. In reassembly be careful to tighten the nut which holds the shaft only slightly to avoid binding the hand. The least friction which will prevent coasting is desired.

BALDWIN SOUTHWARK

Division THE BALDWIN LOCOMOTIVE WORKS, Philadelphia, Pa.

FLEXIBLE POWER FOR INDUSTRIAL

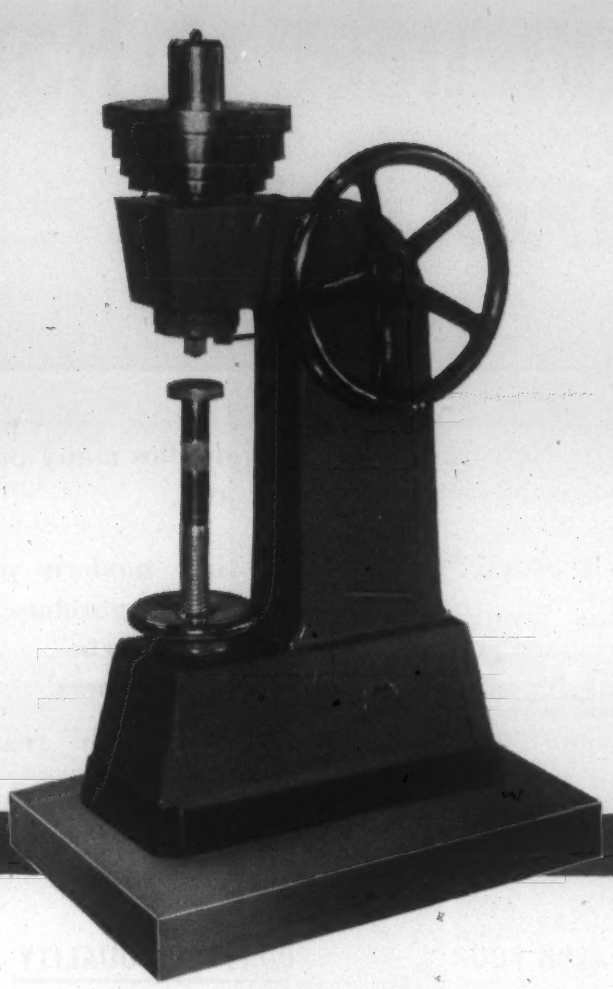


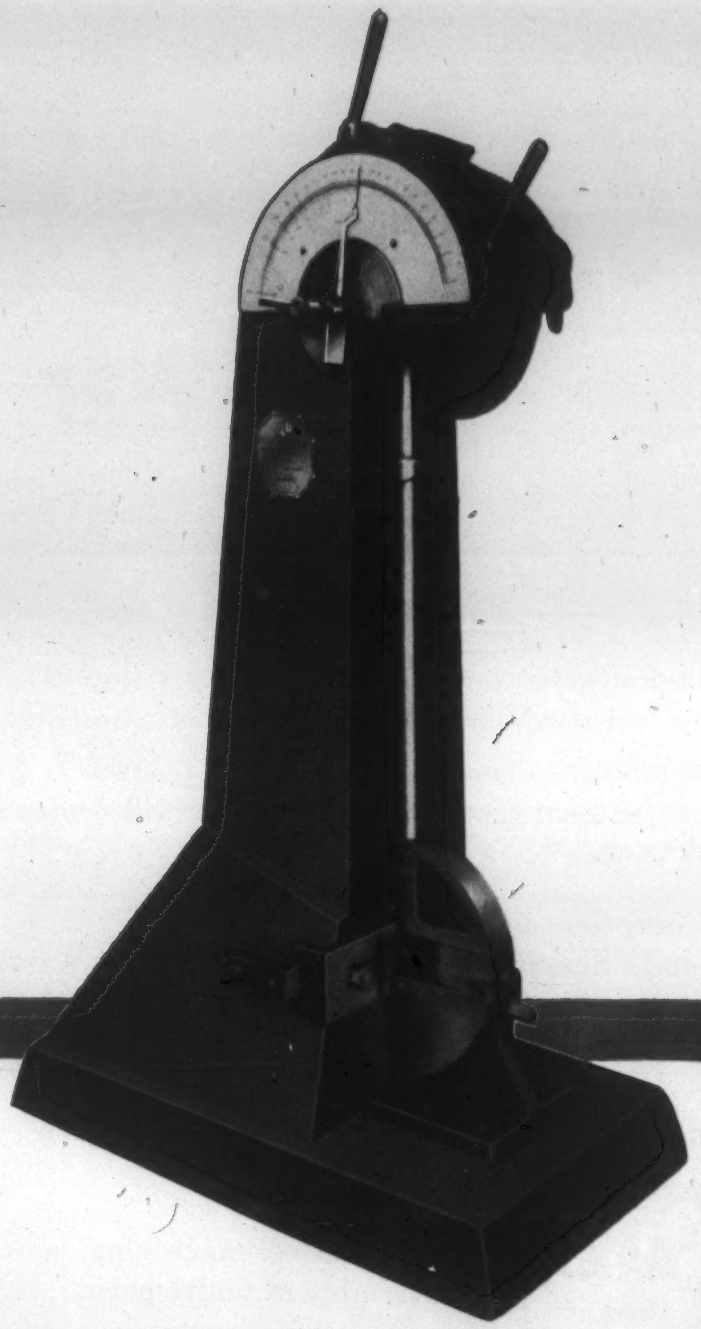


1 **WIDE RANGE OF APPLICATION** (30 kv to 250 kv)—from light alloys up to four inches of steel (with screens).

2 **FLEXIBILITY AND MOBILITY**—Ease of positioning and adaptability to a variety of mountings—overhead crane, jib crane, dolly.

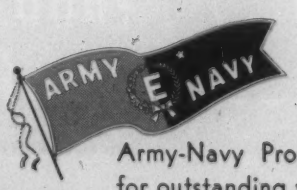
3 **HIGH SENSITIVITY**—Fine focus low absorption gives unusually fine detail and high sensitivity.





BRINELL HARDNESS TESTER

Hydraulic ease of operation, plus ASTM Standards preferred dead-weight loading accuracy, makes quick, accurate material hardness determinations possible for production proof testing. Only one to two revolutions of the hand wheel give the desired results. Equipped for 500 kg., 1000 kg., and 3000 kg. dead-weight pressure on 10 mm. (or 5 mm.) hard Steel Brinell balls. We are in a position to handle your requirements promptly.

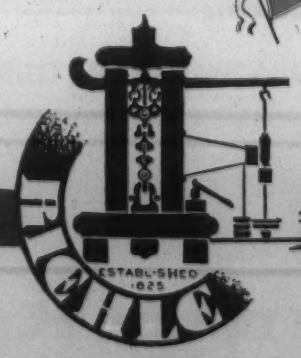


Army-Navy Production Award for outstanding war production.

COMBINATION IMPACT TESTER

The Riehle Precision Combination Impact Tester makes Izod, Charpy and Tension tests. Changes from one test to another can be made in less than a minute. The center of percussion of the pendulum is adjusted to be identical with center of striking tools. All energy-absorbing vibration is eliminated. This tester is widely used throughout industry to speed up the testing of war materials.

RIEHLE will shortly place on the market a new [illegible] foot pound capacity Impact Testing Machine.



"ONE TEST IS WORTH A THOUSAND EXPERT OPINIONS"

RIEHLE TESTING MACHINES

DIVISION OF AMERICAN MACHINE AND METALS, INC., EAST MOLINE, ILLINOIS

5 *reasons why* you need X-Ray for War Production

Why consider it? X-ray provides the only means of non-destructive and foolproof internal inspection of parts and assemblies to control and improve quality.

War products demand it today; keen postwar competition between products and processes will demand it tomorrow.

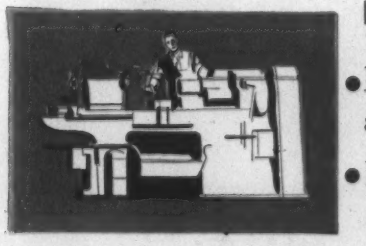
Is it complicated? Contrary to popular conception—no! Simplified controls, developed by Westinghouse, facilitate both training and operation.

In fact, X-ray greatly simplifies many production, design, inspection, analysis jobs.

Is it costly? Like any other modern production tool, industrial X-ray justifies its purchase price by reducing production costs and waste . . . insuring uniform quality and satisfied customers.

Consider these five "down-to-earth" reasons why you should consider X-ray as a necessary war production tool in your plant.

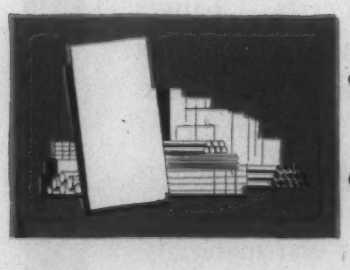
REASON ONE



SAVES MACHINE AND MAN HOURS

- Eliminates machining and assembly of faulty parts.
- Determines exact location and extent of faults in products or assemblies.

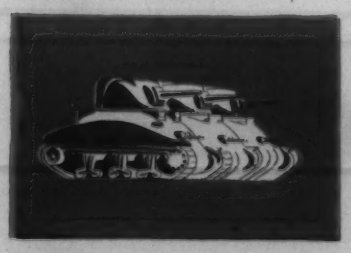
REASON TWO



CONSERVES CRITICAL MATERIALS

- Eliminates rejects. Weeds out bad units.
- Replaces "destructive" tests.

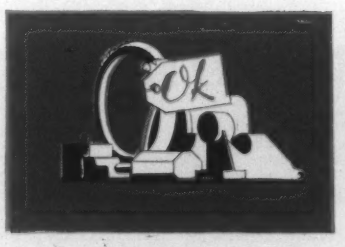
REASON THREE



SPEEDS PRODUCTION

- Easily quick-checks hidden assemblies.
- Permits use of high speed manufacturing processes . . . welding, die casting.

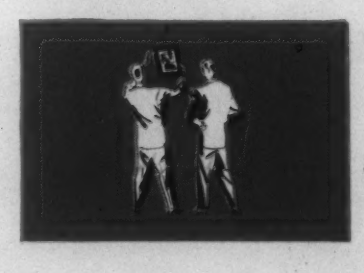
REASON FOUR



CONTROLS QUALITY

- Perfects techniques quickly for quantity production.
- Keeps quality consistent by pictorial comparison or check of all completed units.

REASON FIVE



HELPS TRAIN WORKERS

- Arouses worker interest by giving him exact picture of work he is doing.
- Provides accurate test of worker's qualifications. Serves as basis for visual education in training.

Westinghouse

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X-RAY TECHNICIANS Produce Finest Radiographs Faster and More Economically With SUPERMIX CHEMICALS

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	DEVELOPER	REFRESHER	FIXER
To make 1 gal.	$1.00	$1.15	$1.00
To make 3 gals.	2.75		2.70
To make 5 gals.	4.50	5.25	4.25

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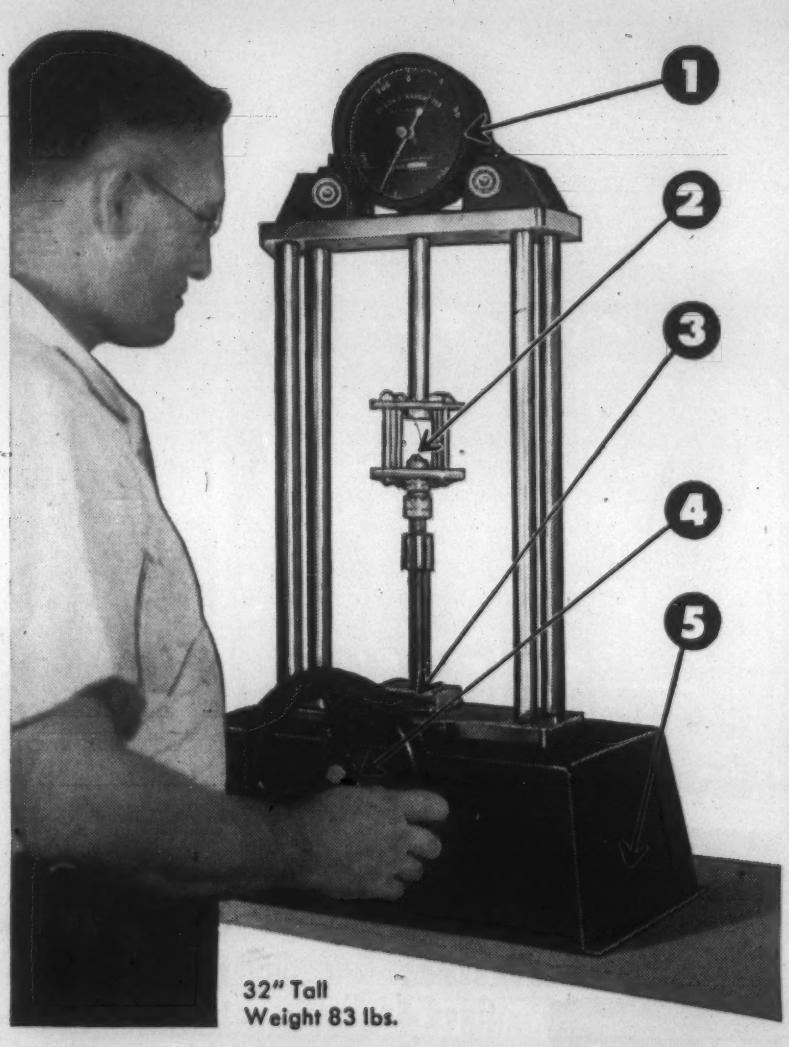
Dillon TENSILE TESTER

Saves Testing Time Material & Money



32" Tall
Weight 83 lbs.

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2. Grips available for every material
3. Finest construction and accuracy
4. Smooth operation, easy to use
5. Compact drive unit; no maintenance worry

Used by Foremost War Plants

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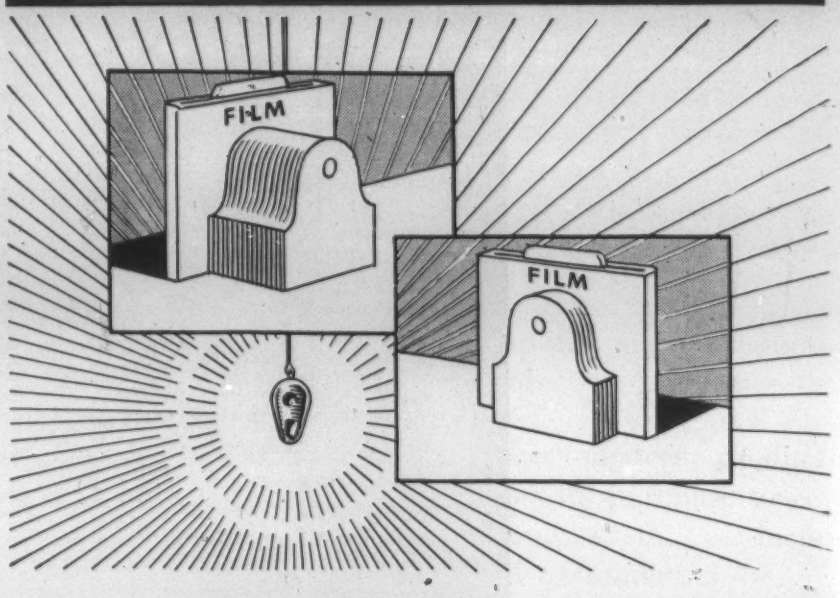
WITH CANADIAN RADIUM



...THROUGH THICK AND THIN

Outstanding in penetration performance, Radium Radiographs provide clear, "inside" pictures of metals up to 10-inch thickness

With the same simple set-up, requiring only a radium capsule and standard radiographic films, you can examine internally, everything from thin welds and castings to metal objects many inches thick.

Variations in the parts of a single specimen are no obstacle to the Gamma-rays of radium. They penetrate the thick and thin in a single exposure and clearly reveal the variations in the radiographic record. No focussing, no outside power, no supervision during exposure is required.

These are some of the many advantages of using radium in the non-destructive inspection of metals. America's metal industries are rapidly adopting this superior inspection method to advance the efficiency and quality of their production.

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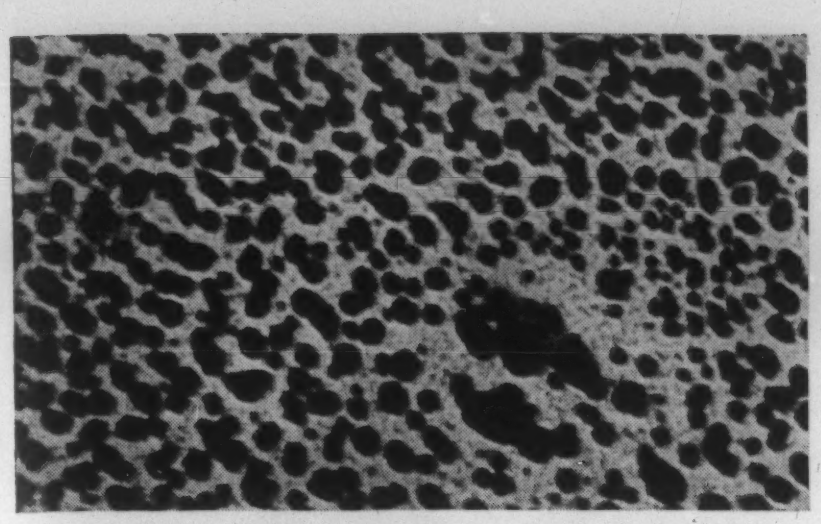
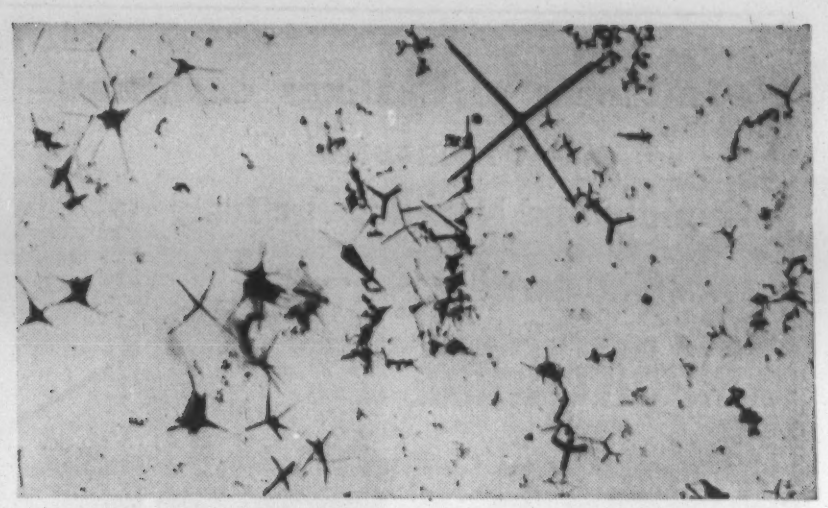
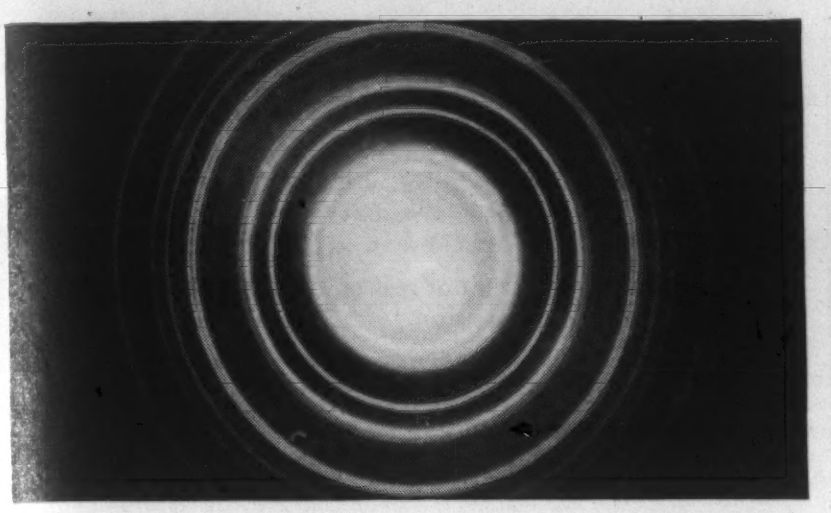


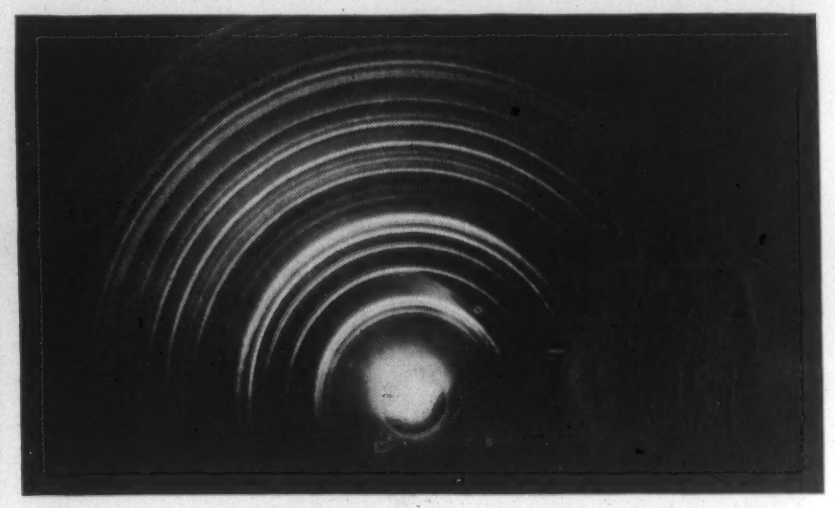
Evaporated silver film, magnification 100,000 x. The RCA Electron Microscope reveals the film is not continuous but consists of extremely fine particles, whose average size is less than one two-hundred-fifty-thousandths of an inch.



Electron micrograph of zinc oxide smoke film formed by burning pure zinc in oxygen. For the first time the very fine parts of zinc crystals can be seen. Below is diffraction pattern of same specimen taken with Electron Microscope diffraction adaptor.



A transmission electron diffraction pattern of the thin silver film shown above. Diffraction patterns indicate the structure and physical arrangement of the atoms in the material.



The reflection method is here used to obtain the diffraction pattern of zinc oxide. When the material is too thick for transmission, the reflection method achieves equally good results.

TAKING THE MYSTERY OUT OF METALS

A case-study of the practical application of the RCA Electron Microscope

Once the pattern of particles in a metal is known, once their size and structure, their position and relationship to each other can be observed and studied, the way is open for research that will yield rich rewards.

The RCA Electron Microscope is playing a new and important part in solving metallurgical mysteries for science. By its inherent high resolving power making possible useful magnifications up to 100,000 diameters, it enables man to see structural details never before within his ken. And through the principle of electron diffraction, which the instrument makes use of by means of a simple attachment, it permits study of atomic lattice of specimens, leading to new, significant analyses.

The RCA Electron Microscope is a compact unit, drawing its power from an ordinary 110-volt, 60-cycle, single-phase A. C. outlet. Its operation can be mastered by any competent laboratory technician.

In *your* plant, the RCA Electron Microscope can be an instrument for important progress in research about *your* products . . . Complete data and literature are available on request. RCA Victor Division, Radio Corporation of America, Camden, N. J.

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—Thickness of Coatings on Metals—
Now Measured
Rapidly and Non-destructively

AMINCO-BRENNER

MAGNE-GAGE

AMINCO

Measures Thickness of:

Magnetic Coatings on Non-Magnetic Base Metals
Non-magnetic Coatings on Magnetic Base Metals
Nickel Coatings on Iron or Steel

RAPID . . . permits testing of a large number of specimens at low cost with little experience.

NON-DESTRUCTIVE . . . will not injure the coating or the base metal, thus effecting great savings.

UNIVERSAL . . . applicable to plane, convex or concave surfaces.

COMPACT . . . PORTABLE . . . weighs only 7½ lbs.

Ideal for Works Control or Acceptance Testing

★

How You Can Profit

by Using the Magne-Gage

The Magne-Gage soon pays for itself (ofttimes in a few weeks, depending on the number of measurements made), and will continue to be a profitable investment long after its initial cost will have been absorbed, because:

★ Measurements are made in a fraction of the time required by conventional methods. The time it saves gives your staff the chance for activity on other jobs.

★ It eliminates costly rejections, since it readily reveals whether or not the thickness of plating conforms to specifications.

★ Every piece tested is unharmed and ready for use or shipment.

★ It eliminates time-wasting, tedious, test procedure.

★ It eliminates the expense involved in replating or discarding specimens spoiled by destructive test methods.

★ No upkeep expense is involved in its use, and no auxiliary equipment or materials such as batteries, acids, tools, etc.

★ Its use readily suggests whether or not a re-design or rearrangement of plant equipment is necessary to produce a more nearly uniform distribution of coating. It lends itself, therefore, to increasing production and a better product.

For works control or acceptance testing, you can apply the Magne-Gage method with profitable results . . . it will pay you to investigate.

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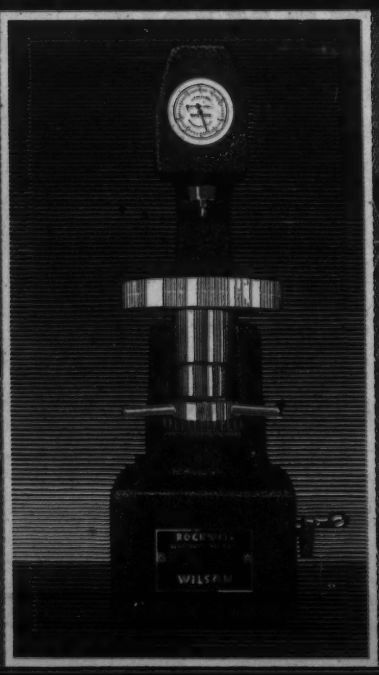
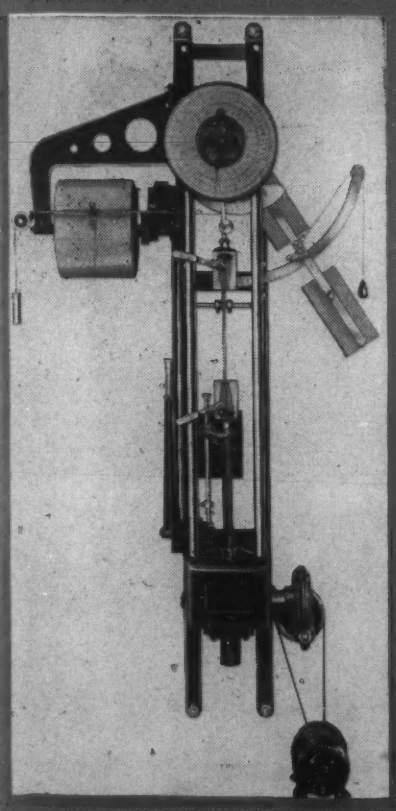


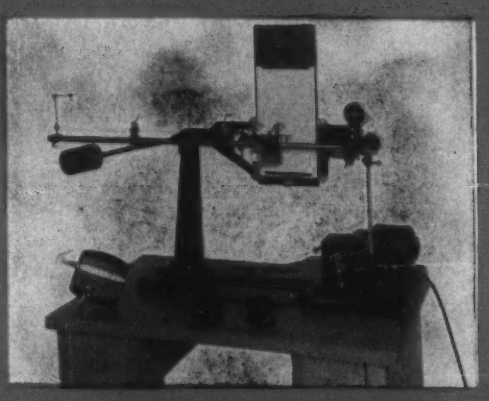
ITS REPUTATION FOR BOTH INITIAL AND ENDURING ACCURACY HAS BEEN GROWING CONSTANTLY FOR A FIFTH OF A CENTURY

WILSON
CONCORD AVE NEW YORK MECHANICAL INSTRUMENT CO. INC.

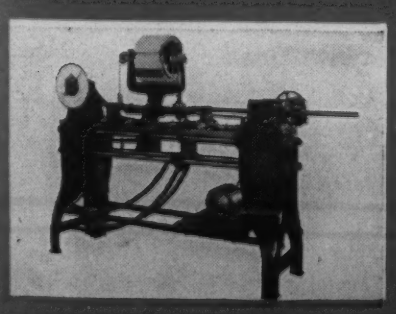
5 miles high, with 5 miles of wire!



Model J-5 for wire. Capacity from 0 to 1,000 lbs. tensile.



This exclusive Incline-plane *Scott Tester is expressly designed for testing the finest vacuum tube grid wires, having a capacity of 0 to 2,000 grams. This machine produces a picturized curve of the behavior of the wire under load, and experience has demonstrated that the durability of a wire can be pre-determined from the pattern of its curve.



Model Q-7 heavy duty wire tester with capacity of 2,000 lbs.

WITH the operation of war materiel depending so greatly upon WIRE—each Flying Fortress, for example, contains about 5 miles of wiring—it is imperative that quality be checked as never before. *Scott Testers are doing this war job, not only proving the finished product, but also speeding its production, and assisting greatly in the selection of material. The 60 models of these machines cover physical test needs from 0 to 1 ton; tensile, hysteresis, compression-cutting (for rubber coating), flexing, etc. The advantages of adequate testing equipment are now more widely recognized than ever before.

If you have need for such equipment to speed and safeguard your war production, we will do everything in our power to assist you.

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Zyglo

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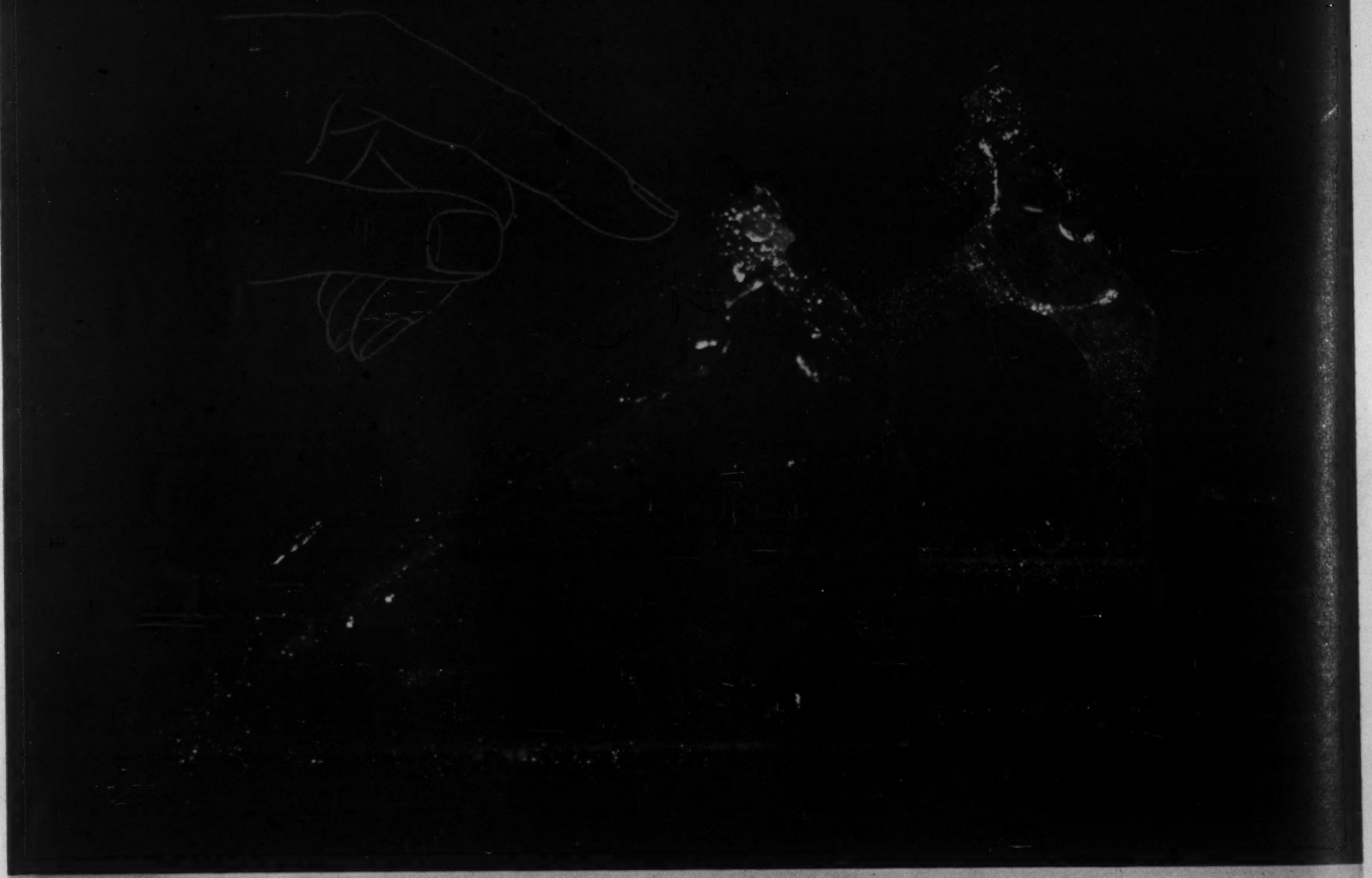
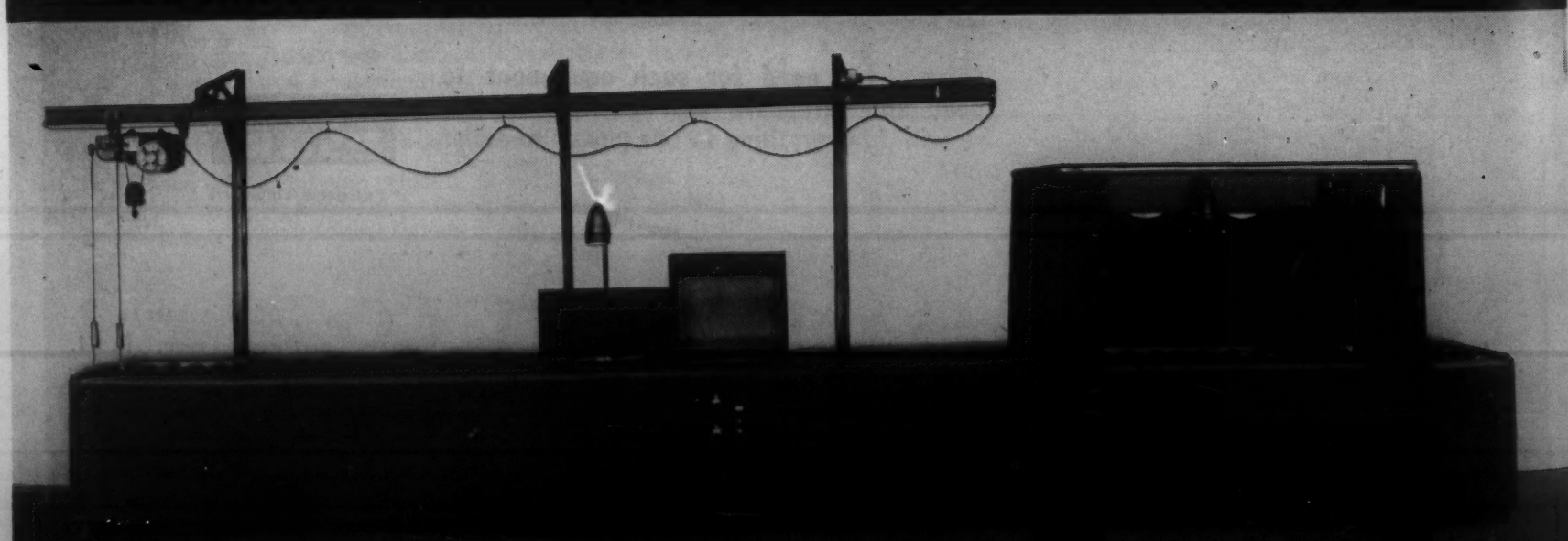
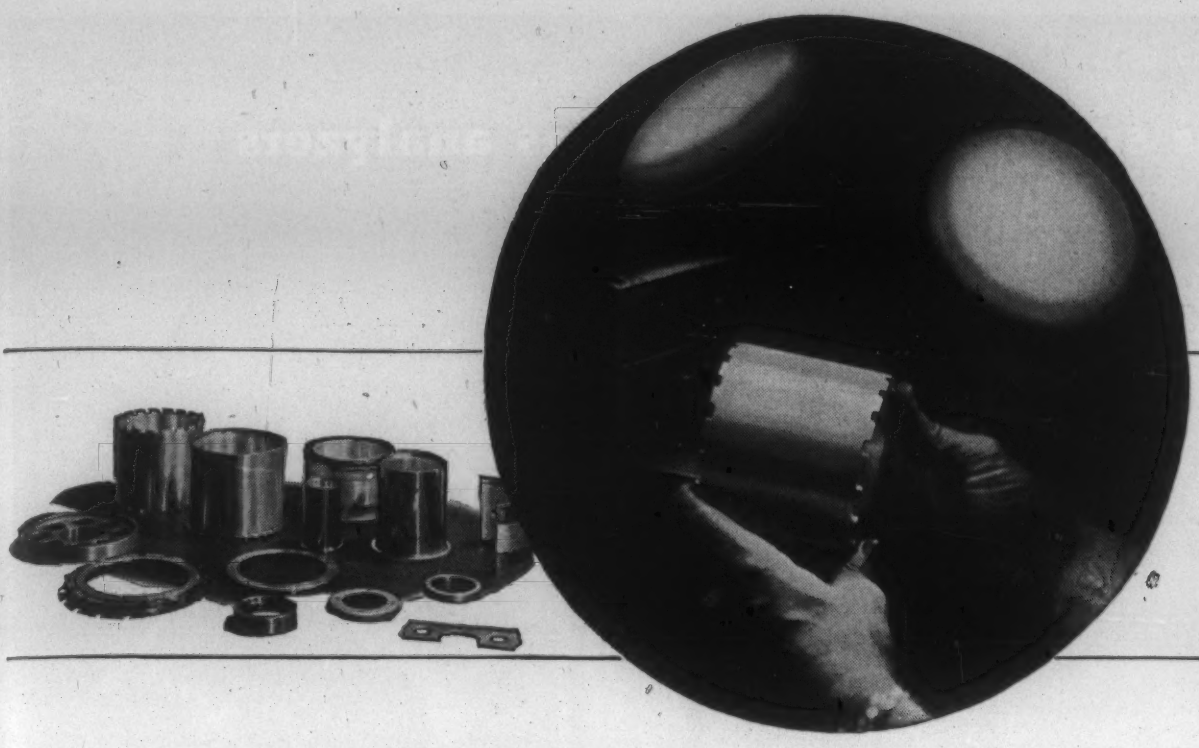
TO PUT THE FINGER ON FAILURE





Large capacity [illegible] Zyglo Inspection Station with overhead monorail.



"Black Light" testing makes certain the bond is perfect on edges of all Mallory Bearings. Under its magic rays, microscopic voids and cracks show up by fluorescence. A filter cuts out visible radiation from the "Black Light", allowing only ultra-violet radiation to pass.

MALLORY Bearings

Meet Critical Loads Superbly

WHERE ordinary bearing surfaces are inadequate to meet the stresses and strains a fighter plane's engine must undergo, Mallory Bearings function marvelously. They can take the terrific pounding and fatigue stresses imposed by suddenly applied loads from a high powered pursuit plane in action.

Mallory Bearings are made by Mallory's Mallosil Process of bonding silver to base metal backings. They provide a tough, homogeneous, heat dissipating silver surface of high fatigue resistance; ample strength and hardness; and high resistance to seizure.

What is more, Mallory Bearings are precision made. Through use of newly designed precision tools and test instruments, skilled Mallory craftsmen have set remarkable records for exactness and uniformity in producing bearings, bushings, pinion races, gear races and other aircraft engine parts. With tolerances measured in split-thousandths, they are turning out ever-increasing quantities of precision parts with an accuracy and uniformity considered impossible only a few short months ago.

Continuous experimental designing and testing indicate even greater results for the future. The experience and technique gained in War production will be invaluable for commercial motors development when Peace has arrived. Consult us on the possibilities of the Mallosil Process for you.

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Hints for special atmosphere gas analyzers

Information supplied by an Industrial Publication

Analysis of special atmosphere compositions in heat treating furnaces, periodic or otherwise, is an excellent means of insuring consistent results. However, two precautions should always be observed in the interests of accuracy.

First; it should always be remembered that slow cooling of the furnace gases from operating to room temperature will cause reactions that alter the composition of the sample. The metal in the sampling tube may also affect the sample composition.

Speedy withdrawal of gas samples, followed by instant cooling to room temperature by a cold water jacket around the sampling tube will minimize changes. In high temperature work, sampling tubes of material similar to that of the charge will be in better equilibrium with the furnace gases.

Second; when the Orsat method of analysis is used, analyses are on a "dry" basis. Separate tests, such as passing the gas over a dehydrating agent such as phosphorus pentoxide ($P_2 O_5$), alumina ($Al_2 O_3$), for lime (Ca O) should be used to determine the presence of water vapor.

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.

ARMY E NAVY

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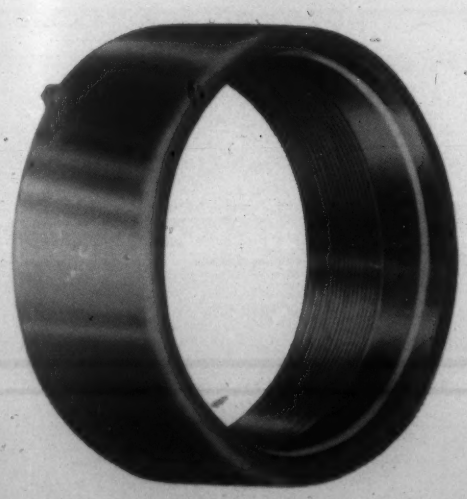

● At the present time we have ample capacity and equipment for the manufacture of brass or other copper base alloy sand castings.

In addition to the most modern equipment we have experienced men who have been in our foundry for years. These men have the "know how" for the production of close tolerance work. The castings produced are of uniformly high quality with close grain structure.

We have our own Tool Room and Pattern Shop for any necessary tools or patterns to turn out the job. We can supply them rough, machined, polished or plated.

We manufacture the standard line of STREAMLINE pipe fittings for heating, air conditioning, water works, plumbing or refrigeration use, *or to your specifications.*

If you need castings in a hurry, write us *now.*

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HOW AIRCO ENGINEERED *FLAME CUTTING*

to do this job 120 times faster

Cutting hatchway openings out of heavy deck plates was a difficult shipbuilding problem. The methods available required many machining operations... the work progressed slowly and the cost was high.

Flame cutting could facilitate this operation, but could it produce the continuous bevel and rounded corners required? This was the question put to Air Reduction's research and engineering departments.

Before long they developed the solution—a special flame-cutting machine that cut the shaped openings with beveled edge and rounded corners—all in one speedy flame cutting operation! The job was done in 1/120th the time formerly required, and the cut was so clean that the metal cut out served as a tight-fitting hatchway cover.

This special Airco machine—the Airco Polygraph—has since become standard equipment in many shipyards and war production plants. It is motor-driven and moves on a formed metal track which is also the template of the shape to be cut. With this machine, beveled, circular, rectangular, or irregular shaped openings may be speedily cut with considerable savings in time, cost, and materials.

If you work with metals you will want to know the many ways in which flame cutting and arc welding can help you to speed production. The services of Air Reduction's Applied Engineering Department are available for technical assistance through any Air Reduction office.

Air Reduction

General Offices: 60 EAST 42nd ST., NEW YORK, N. Y.

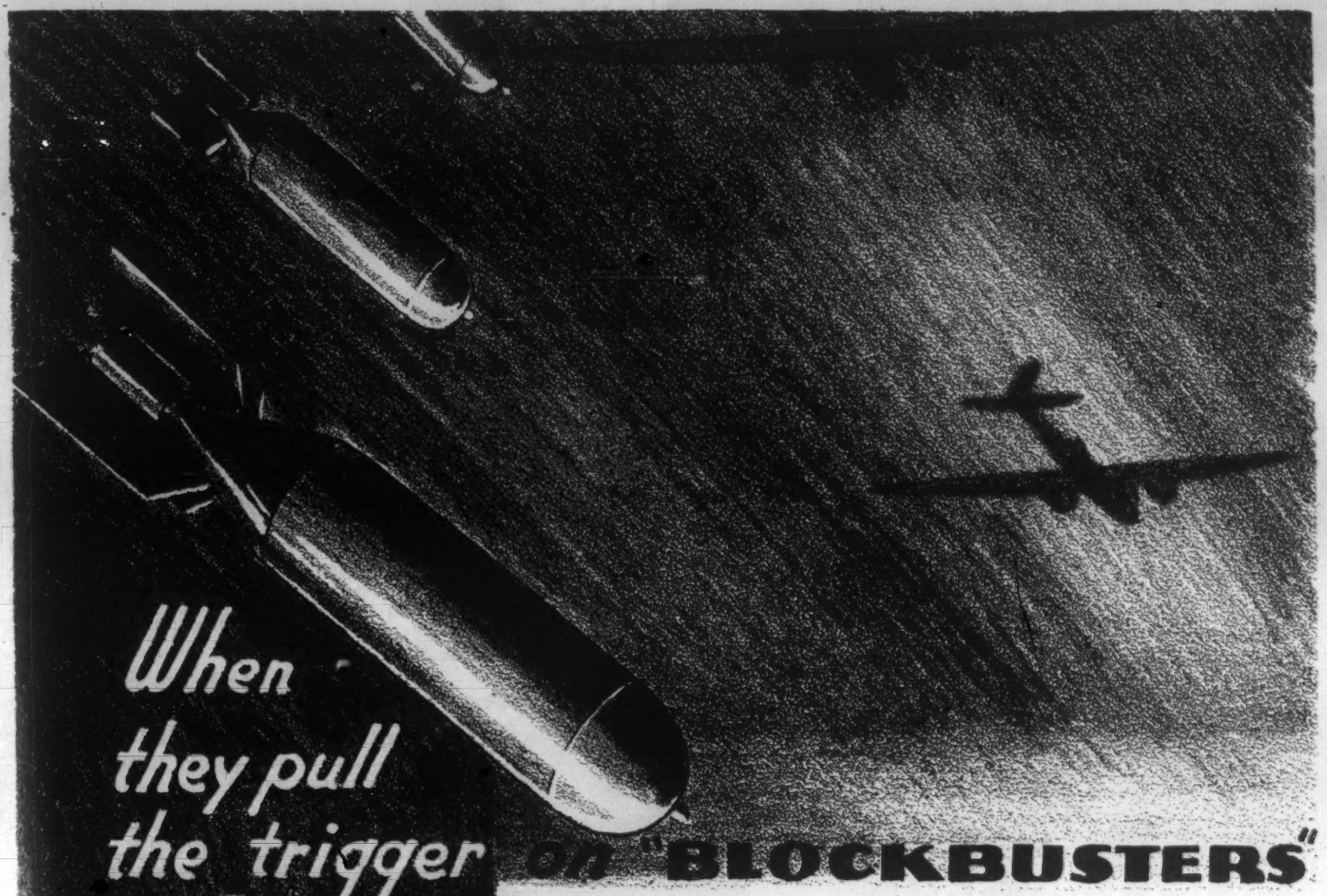
IN TEXAS: MAGNOLIA-AIRCO GAS PRODUCTS CO.

General Offices: HOUSTON, TEXAS

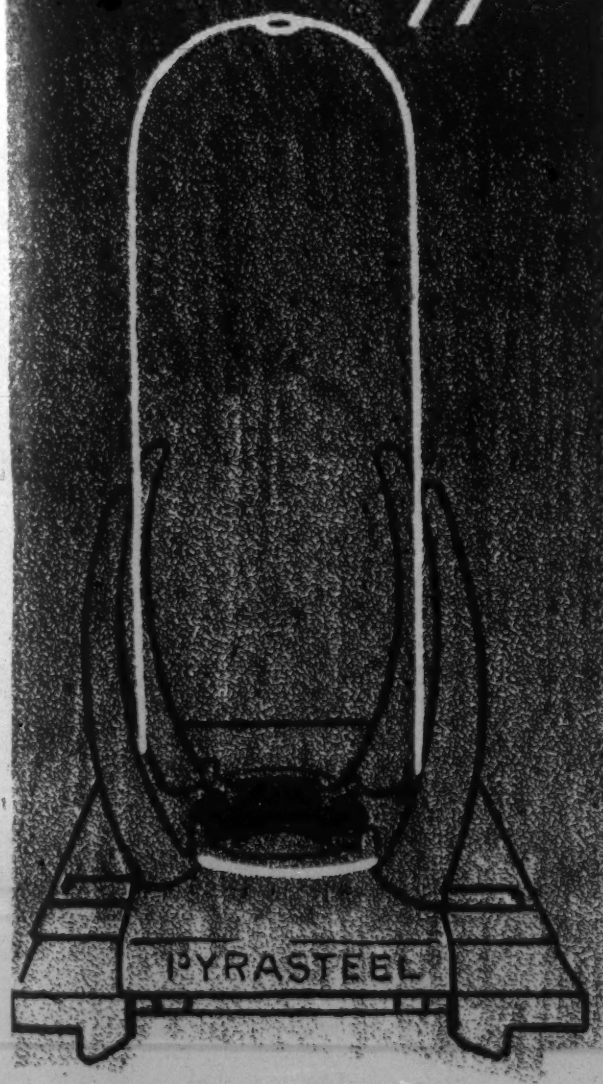
AIRCO

WILSON

IDLE CYLINDERS ARE PRODUCTION SLACKERS: *Keep 'em rolling for victory!*



When they pull the trigger on "BLOCKBUSTERS"



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Flexible Tray

THE round-the-clock raids of destruction, now softening up enemy resistance for the "second front," are made possible not only by the skill and courage of bomber crews, but also by the men and materials backing them up in the production lines.

One of the basic materials that is working "behind the scenes" . . . but very much in the spotlight of industry . . . is this modern **heat-resisting alloy**

PYRASTEEL

It is a major factor in maintaining output and quality in the heat-treating of shells and munitions . . . because PYRASTEEL gives long and dependable service at high temperatures.

PYRASTEEL flexible trays, chain belt conveyors, annealing pots, rollers, guides, grids and other furnace parts, are a few of the many items which are all-important aids to American industry in today's huge war production program.

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PYRASTEEL for high temperatures
KEDZIE AVE & 37TH ST.
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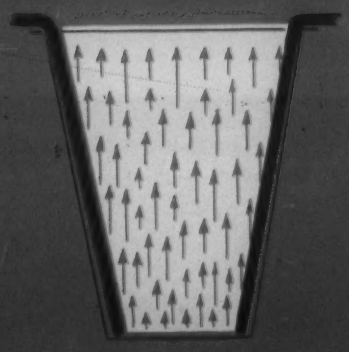
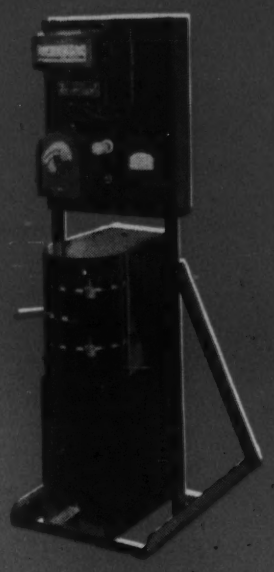
Makers of Alloy Steel for 30 Years
EVANSTEEL for strength and wear

This Simple Principle of Design

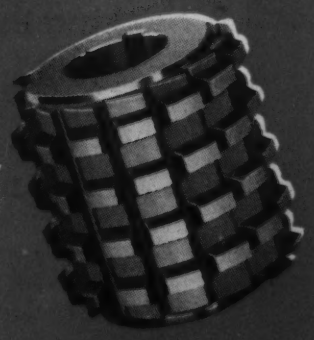


Plus this Fool-Proof Heat Control



Guarantees that this Upton Electric Salt Bath Furnace

Will Harden this Hob so Accurately and Uniformly



that it Will Not Require Finish Grinding!

Commercial Heat Treaters Do Better Work with *UPTON Electric Salt Bath Furnaces*

The three principal problems of commercial heat treaters are all solved with Upton Electric Salt Bath Furnaces and Upton heat measuring controls.

Inexperienced help can now be quickly trained in the use of the Upton Heat Measuring Control to get perfect results, *all the time*. It tells when the work is done. It even signals him when he has made an error in timing adjustment.

Moly steels are easily handled with the Upton Electric Salt Bath Furnace. *During* heating the entire tool is safely submerged in the salt. *After* the tool is removed, the salt still coats the surface and prevents oxidation.

Predictable size change is so exact—with Upton Electric Salt Bath Furnaces and the Upton Heat Measuring Control—that finish grinding is entirely eliminated on many tools—the same kind of tools that formerly required finish grinding.

Electrodes for heating the salt in the pot are usually placed in the diagonally opposite corners of the pot—out of the working area. These electrodes can be changed in a few minutes, without special equipment and are usually of low cost mild steel.

The greatest amount of heat is generated within the salt near the bottom of the pot. The heated salt can then rise normally, naturally and circulate throughout the entire bath. (The proof of this is the absolute uniformity of work—the absence of distortion in special tools of large size.)

Upton Electric Salt Bath Furnaces are available for inspection in Detroit under actual *Commercial* heat treating conditions. Ask for complete information now. (To save time, why not give us a description of the work to be handled?)

Upton ELECTRIC FURNACE DIV.

UPTON Electric Salt Bath Furnaces are available for all types of Heat Treating from 300° to 2500° F.

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Then think in terms of Metal Spinning and particularly *Spincraft's combination of spinning, fabricating and assembling—set up to translate your blueprinted ideas into finished products within a matter of days, not weeks or months. How this is achieved will be detailed in a new data book now being compiled.

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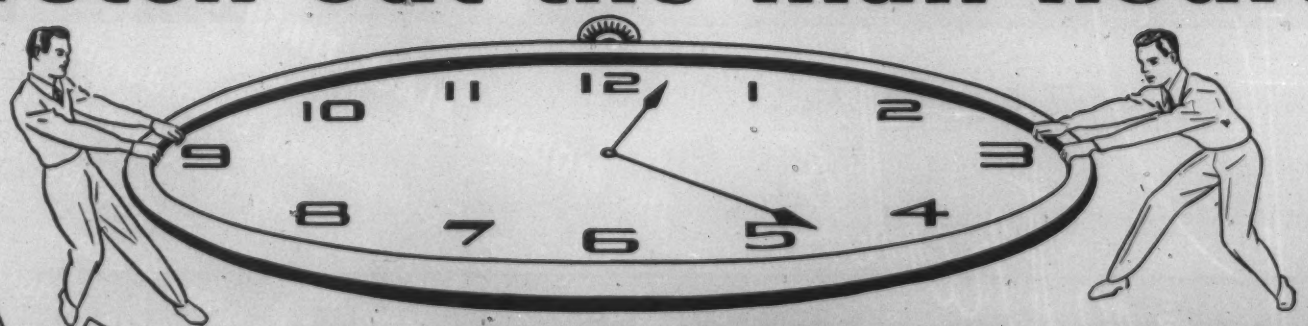

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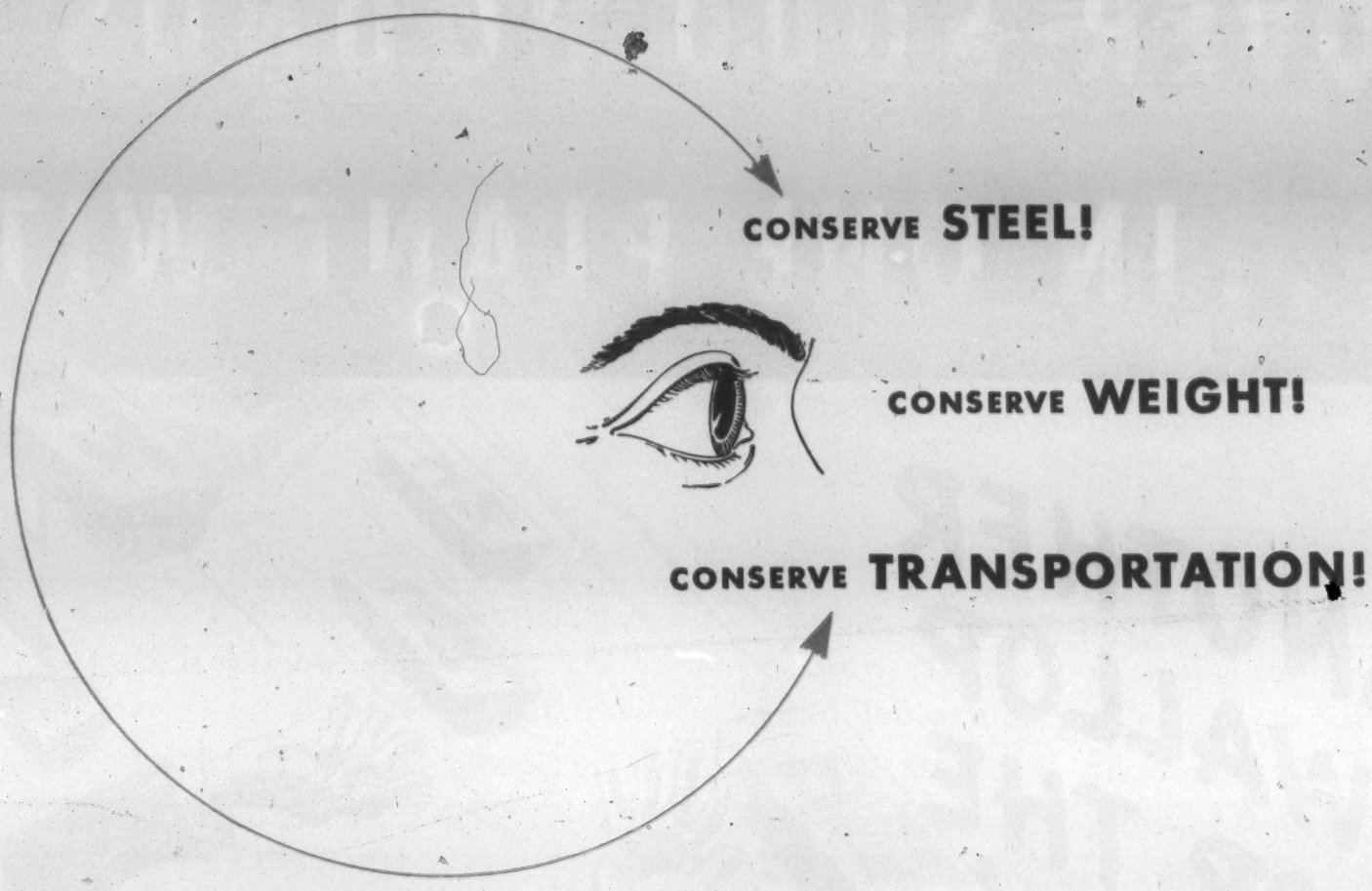
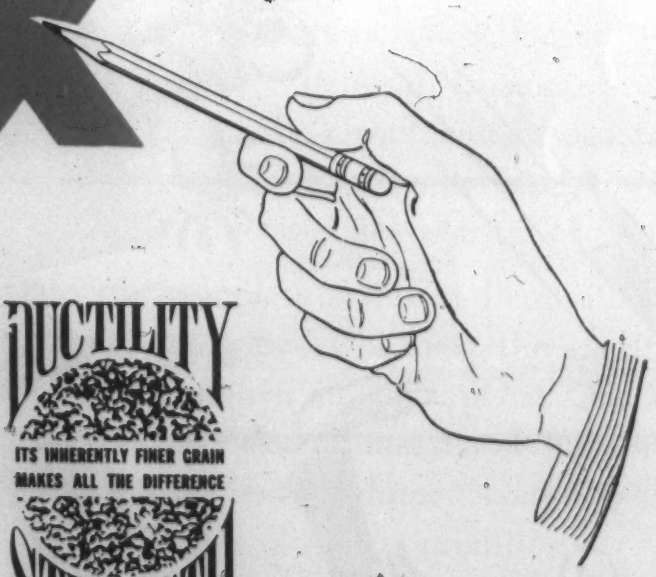


MAKE YOUR PRODUCT OF

N-A-X

HIGH TENSILE



When you build your product of N-A-X HIGH TENSILE you conserve 3 ways—you conserve steel, you conserve weight, and you conserve transportation.

With N-A-X HIGH TENSILE, you need less steel to provide a given strength factor. That saves steel! You can build lighter without any sacrifice of strength. That saves weight! And when you save weight you save transportation—and that's a vitally important factor today in speeding our war effort.

N-A-X HIGH TENSILE is the answer to many a production problem today. Its high ultimate strength, high yield point, unusual ductility, easy weldability, and its unusually high resistance to impact and fatigue in sub zero cold or blistering heat—makes N-A-X HIGH TENSILE a superior steel for hundreds of exacting applications.

Why not investigate N-A-X HIGH TENSILE for your product? A Great Lakes Engineer will be glad to show you how this unusual steel can be used to advantage. Send for new booklet on N-A-X 9100 Series—and useful Hardenability Chart.

DUCTILITY
ITS INHERENTLY FINER GRAIN
MAKES ALL THE DIFFERENCE
STRENGTH

GREAT LAKES STEEL CORPORATION
Detroit, Michigan
Sales Offices in Principal Cities

NATIONAL STEEL

Division of
NATIONAL STEEL CORPORATION
Executive Offices · Pittsburgh, Pa.

OVER 5000 POUNDS OF

...IN ONE PLANT WITH

ZINC A WEEK SAVED...
PENNSALT CLEANER

EVERY POUND of essential metal saved is a blow against the enemy. Pennsalt Cleaners are doing forthright service in many industries, helping to conserve vital time and materials by faster, better metal cleaning—at lower cost.

Saving zinc by the proper removal of oil, grease and other soils from structural steel before galvanizing is an example. In one large fabricating plant rejects after galvanizing ran 20 to 25 per cent before Pennsalt Cleaners were introduced.

Now for the Pennsalt method:—Crates of steel parts are lowered by crane into a tank containing a steam-heated solution of Pennsalt Cleaner. After ten minutes they are taken to a rinse tank, then as they are removed they are water-sprayed. Pickling, rinsing, fluxing and coating operations proceed as before.

Result? Virtually *no* rejects! Average daily production up 20 per cent! And the zinc formerly lost due to stripping rejects now is *saved at the rate of over 5000 pounds per 80 hour week!* Over 260,000 extra pounds a year to help win this war. And this saving was made by only *one* manufacturer!

Many leading plants in every field of metal manufacture are saving needed materials and speeding cleaning operations with Pennsalt Cleaners. They are often able to dispense with hand labor and precleaning . . . and so cut cleaning costs.

In a wide range of duties, Pennsalt Cleaners are removing and preventing the redepositing of dirt—grease, oil, emery dust, rouge, carbon smut, grit. The metals and alloys they clean include carbon and alloy steels, stainless steel, copper, aluminum, zinc, nickel, nickel silver, Britannia metal, brass and bronze.

Whether the part is rolled, forged, stamped, drawn or cast . . . Pennsalt Cleaners are producing a remarkably clean, smooth surface that leads to a better job of Bonderizing, Parkerizing, enameling, painting, galvanizing or plating.

In the complete series of Pennsalt Cleaners, there is one which will meet the specific metal cleaning problem in *your* plant. All Pennsalt Cleaners have exceptional dissolving and emulsifying action, extraordinary lasting power and highly efficient cleansing qualities.

Let one of our experienced technical staff help you choose the Pennsalt Cleaner that will do most to save time, materials and money in your particular metal cleaning operations. Or write fully to our Pennsalt Cleaner Division, Dept. MA.

PENNSYLVANIA SALT MANUFACTURING COMPANY

Chemicals

1000 WIDENER BUILDING • PHILADELPHIA, PA.

NEW YORK • CHICAGO • ST. LOUIS • PITTSBURGH • WYANDOTTE • TACOMA

This is no time to take chances with war production

This year calls for a supreme effort on the part of every manufacturer engaged in war production to deliver the goods—to get there "fustest with the mostest" — and whatever tools of war are sent must be the finest that skilled American workmen can produce. This is no time to take chances with your war products.

DU-LITE Black Oxide Steel Finish has long demonstrated its superior qualities — its uniformity — its remarkable characteristics as a rust preventive — its aid to lubrication — its economical, fast application.

Where there are steel parts to be finished Du-Lite will prove its value. This statement is based on the experience of hundreds of leading manufacturers throughout the country, producing aircraft, tank and marine engines, arms, bomb parts, cartridge clips, instruments, tools and machine parts.

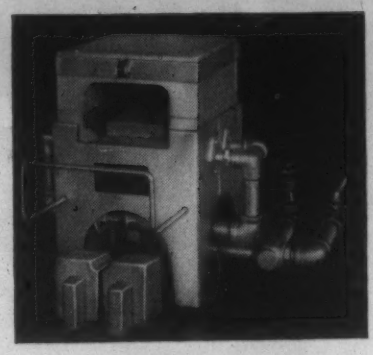
Without question, if you want your product to measure up to the most rigid specifications, use Du-Lite for the finish.

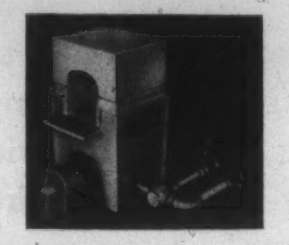
DU-LITE CHEMICAL CORP.
MIDDLETOWN, CONNECTICUT

—For That Odd Job that can't wait!

— Every Tool Room should have one of these versatile Bench Furnaces.

HARDENING
FORGING
ANNEALING
TEMPERING
BRAZING, ETC.





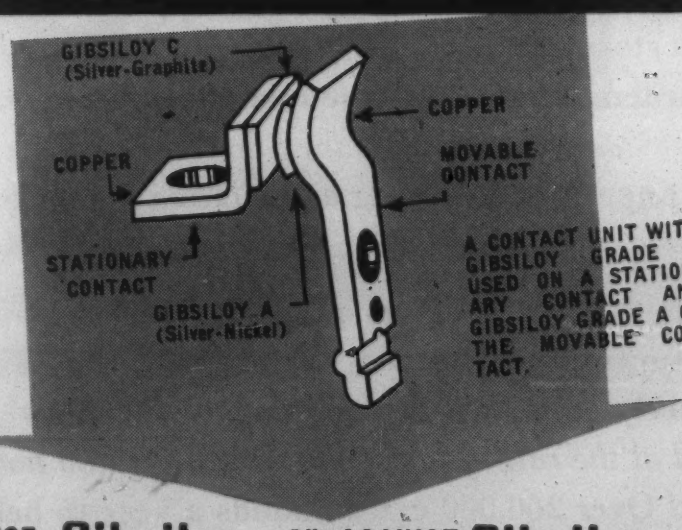
HERE'S WHY

1. Only 10-15 min. to heat up.
2. Low investment cost.
3. Eliminates sending out work thus saving time and money.
4. Clean to operate—no smoke or dirt.
5. Atmosphere easily made rich or lean, as desired.

Write for our complete catalog.

American Gas Furnace Co.
Elizabeth, New Jersey

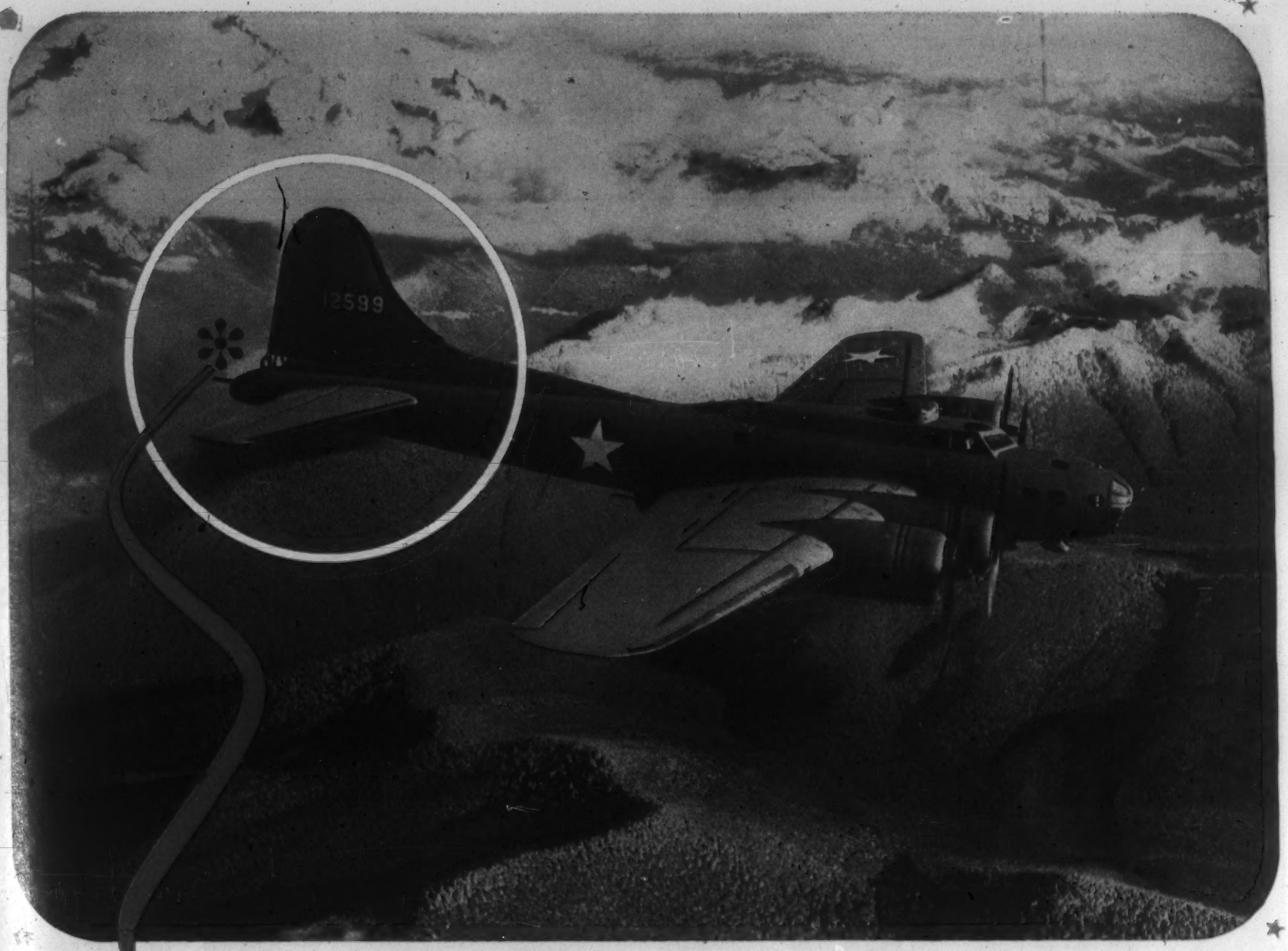
FOR NON-STICKING, LOW RESISTANCE CONTACT . . .



USE Gibsiloy "C" AGAINST Gibsiloy "A"

In addition to non-sticking, non-welding characteristics, Gibsiloy "A" Contacts operating against Gibsiloy "C" Contacts have the advantage of low contact resistance. This combination gives dependable circuit breaking performance, either in oil or in air, and is not adversely affected by surrounding atmospheric conditions. Typical applications include both air and oil circuit breakers, relays, and contactors (as illustrated). Consult us on your contact problems.

Gibsiloy ELECTRICAL CONTACTS
Manufactured by
GIBSON ELECTRIC COMPANY
8356 Frankstown Ave., Pittsburgh, (21), Pa.



How does a Bomber Pilot

COMMAND TONS OF PRESSURE WITH POUNDS OF EFFORT?

YOU'VE seen a heavy bomber change direction in the air—climb, bank or nose down. It looks easy, although the airstream is actually piling tons of pressure against the rudder and tail surfaces.

It even looks easy in the cabin, as you watch the pilot handle his controls. And it is easy, because a little trick called an "amplidyne"—which steps up electrical power input to the control motors about 10,000 times—is doing the work for him.

This mechanism, a development of one of the nation's largest electrical manufacturers, depends upon the special properties of an Allegheny Ludlum Electrical Steel to achieve its results. Into the steel, as it must be in the amplidyne itself, is built reliability, uniformity and stamina.

Although important, this is only one of the dozens of wartime electrical devices to which Allegheny Ludlum Electrical Alloys have lent desirable qualities of magnetism, high permeability, or high resistance. The list covers control, detection and communications equipment for all the services.

For engineers and production men desiring certified technical information on these special alloys, write for a copy of the *"Electrical Materials Blue Sheet"* or for the assistance of our Technical Staff.

ADDRESS DEPT. MA-3

Allegheny Ludlum
STEEL CORPORATION
BRACKENRIDGE, PENNSYLVANIA

Steel-Makers to the Electrical Industry

A-8826 . . . W & D

SHIRT-SLEEVE

Research, to be resultful, must go beyond the laboratory, out into the "proving ground" of plants. This requires a staff of practical engineers who can roll up their sleeves and convert theory into practice . . . men who can take over a processing job under actual operating conditions. Houghton men are that kind. Our augmented technical staff is on call to help solve metal-working and heat-treating problems.

Ask Houghton

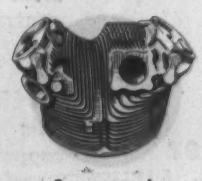
D RESEARCH...

that helps transform metal men from worriers to warriors

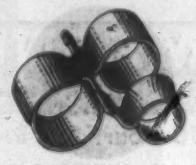
Soldiers on the production front have their troubles these days—troubles resulting from the speed-up and the many new processes they have had to learn. They ask for practical help. Any service that wipes out worries makes plant men better fighters. That they get such aid is proved by these actual instances from Houghton field reports.

Shells of war-time steel had to be quenched in oil possessing a fast quenching speed. Houghton developed such an oil, then put technical men in shell plants to offer suggestions on spray jets and oil cooling which would produce refinement of grain structure, enabling shells to meet yield strength specifications.

Barrels for machine guns, small arms, AA and medium caliber guns present a tough job of drilling, reaming and rifling. Machine speeds could not be stepped up until the right cutting fluid was used. Houghton worked with machine tool builders and gun makers at the outset of the defense program . . . today supplies most of the cutting oils and concentrates used for barrel machining in the nation's huge armament program.



Aluminum aircraft engine cylinder heads are oil-sand core jobs for which huge new foundries have been built. We have worked closely with these foundries on the problem of core oil and spray oil, developing products and checking core baking procedures, which has enabled mass production on a scale believed impossible a few years back.



Cartridge links must be uniformly hardened by oil quenching. We not only supplied a fast-quenching oil, but also offered suggestions for agitation of oil within the chute from the furnace to avoid soft spots. These links are Parkerized, then protected against rust with an approved Houghton rust preventive developed specifically for this purpose.

Shortage of brass required industry to learn how to draw cartridge cases from steel, a job tackled cooperatively by the entire industry. To smooth the flow of steel, Houghton developed drawing compounds early in the experimental stages. Today these are enabling the mass production of steel cases with a very minimum of rejections.

★ **And so it goes, throughout industry where metal is being processed. We offer freely the service of our technical men for field consultation. Ask Houghton.** ★

E. F. HOUGHTON & CO.

303 WEST LEHIGH AVENUE, PHILADELPHIA

CHICAGO • DETROIT • SAN FRANCISCO • TORONTO

Do You Have Trouble Cleaning These Metals?

Try PERMAG Cleaning Compounds

—Steel — PERMAG Ferro-lyte, Anodic steel cleaner used at low concentrations. Used by prominent industries.

—Brass
—Copper
—their Alloys — PERMAG Cupro-lyte, Cathodic cleaner for brass and copper, and alloys of these metals so prominent in war work.

—Aluminum — PERMAG Aluminum Cleaner, for aluminum prior to anodizing and finishing, and for white metals—Zinc and Lead Die—Cast, etc.

MAGNUSON Cooperative Service for Industry

Aids manufacturers in finding the best solution for their cleaning problems. Write for details. No obligation for interviews.

Warehouses in Principal Cities

MAGNUSON PRODUCTS CORPORATION

Representatives from Coast to Coast

50 Court St., Brooklyn, N. Y.

In Canada: Canadian PERMAG Products Ltd., Montreal, Toronto

OXIDINES

Black Finishes go to War

OXIDINE B — **BLACK for brass and copper**

OXIDINE Z — **BLACK for zinc**

OXIDINE CI — **BLACK for cast iron**

the JETAIL — **BLACK for steel**

—with Jetoils for improved rust and salt spray resistance

If you have a black finishing problem, for consultation on protective coatings—

WRITE, WIRE, OR PHONE

ALROSE CHEMICAL COMPANY

Providence, Rhode Island — Tel. Williams 3000 - 3001

SIL-X

REG. TRADE MARK

NEW EXOTHERMIC AGENT FOR INTRODUCING SILICON TO STEEL AND IRON IN OPEN HEARTH OR CUPOLA OR BY LADLE ADDITIONS

CHROMIUM

MINING AND SMELTING CORPORATION LTD.

SAULT STE MARIE, ONTARIO

Miller and Company (SOLE AGENTS)

CINCINNATI - CHICAGO - ST. LOUIS

The Amazing Petroleum Industry

TO UNDERSTAND THE IMPORTANCE OF PETROLEUM IN WAR AND PEACE—*READ*

By V. A. KALICHEVSKY

THIS BOOK paints an interestingly vivid picture of the world's most important raw material—petroleum. In non-technical language it tells simply what petroleum is—how it is obtained—what it does.

Perhaps you have often wondered how to strike oil, how it is transported and refined. Maybe you have wondered what makes your automobile engine knock or why our big bombers use high octane gasoline. Without petroleum there would be no synthetic rubber—but HOW can rubber come from oil? This book answers these and hundreds of other timely questions.

A fascinating book—that highlights the story of petroleum and gives the reader an authoritative understanding and appreciation of the raw material that will help us win the war—and secure the peace—Petroleum.

$2.25 at leading bookstores or direct from

REINHOLD PUBLISHING CORPORATION 330 W. 42nd St. New York, N. Y.

LITHCARB

..eliminates all cleaning and descaling operations in carburizing

- FAST, BRIGHT GAS-CARBURIZING
- NO SCALE, SOOT OR COKE AT ANY TIME
- ATMOSPHERE ADJUSTMENTS ARE ENTIRELY ELIMINATED
- NO SPECIAL SKILL IS REQUIRED OF OPERATOR
- THE ONLY CHEMICALLY NEUTRAL ATMOSPHERE
- VERY LOW OPERATING AND MAINTENANCE COSTS

Another important installation in an ordnance plant now operating 100% on war production.

Utilizing a *Metallic* lithium atmosphere

Basic inherent advantages of the LITHCO controlled atmosphere for hardening, are embodied in the LITHCARB process to obtain fast, coke-free bright carburizing. The function of the lithium vapor, here again, is its neutralizing reaction with oxygen, water vapor, carbon dioxide and other contaminating influences. The fact that the surface of the steel is kept bright, scale-free and soot-free, not only increases the carburizing speed, but effects substantial production and assembly economies. Only a fraction of the gas is required.

LITHCARB Atmosphere Furnaces are participating prominently in the war effort in vital ordnance production. The quality of results obtained through the LITHCARB process—the depth of case, its absolute control, and uniformity of structure—attest to its vital importance. The extreme simplicity of the process—automatic operation, its ease of operation, and lack of adjustments—corroborate a definite achievement in the carburizing of steels.

* * * *

Literature describing the LITHCARB process for fast bright carburizing, and LITHCO scale-free and decarb-free hardening, is available on request. Write today; no obligation.

A MIRACLE OF CHEMISTRY BASED ON SOUND ENGINEERING PRINCIPLES

THE LITHIUM COMPANY

ADMINISTRATION OFFICES:

111 SYLVAN AVENUE NEWARK, NEW JERSEY

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METAL INDUSTRIES CATALOG

• METAL INDUSTRIES CATALOG contains reference data from over 100 manufacturers of equipment and materials for the metal-producing and metal-working industries.

• If you do not have access to a copy, please write us on your company letterhead.

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When Johnny, Mike, Pete and Mary

come marching home!

THAT will be the Great Day when the victorious boys—and the girls—come back to the wide open arms of America.

A Great Day that isn't so far away.

They probably haven't realized it but Industry has found the time somehow, apart from its tremendous war effort, to plan and develop new things that will enhance and improve our future living.

New developments in metals and alloys, fuels, plastics, chemicals, rubber, foods, synthetics, textiles—and electronics which will be reflected in the coming higher standards of peace-time living.

Right now in thousands of laboratories—in pilot plants—on the drawing boards—in the conference rooms—Industry is experimenting, planning, discussing.

And in many of these almost revolutionary processes that are already under way or are being planned, super refractories by Carborundum are considered as vitally important factors.

If you, too, are working on or considering a new process involving the use of refractories, there is undoubtedly one or more Carborundum Brand Super Refractories that will improve the efficiency of your operation.

It may be that your conditions call for a refractory having high refractoriness or high heat conductivity.

Perhaps resistance to spalling or softening or great strength at elevated temperatures is most important.

Whatever the essential quality, characteristic or application may be, we are confident that super refractories by Carborundum and our research and engineering will prove invaluable.

We would welcome the opportunity of consulting with you.

REFRACTORY **CARBORUNDUM** PRODUCTS

Refractory Division, **THE CARBORUNDUM COMPANY,** *Perth Amboy, N. J.*

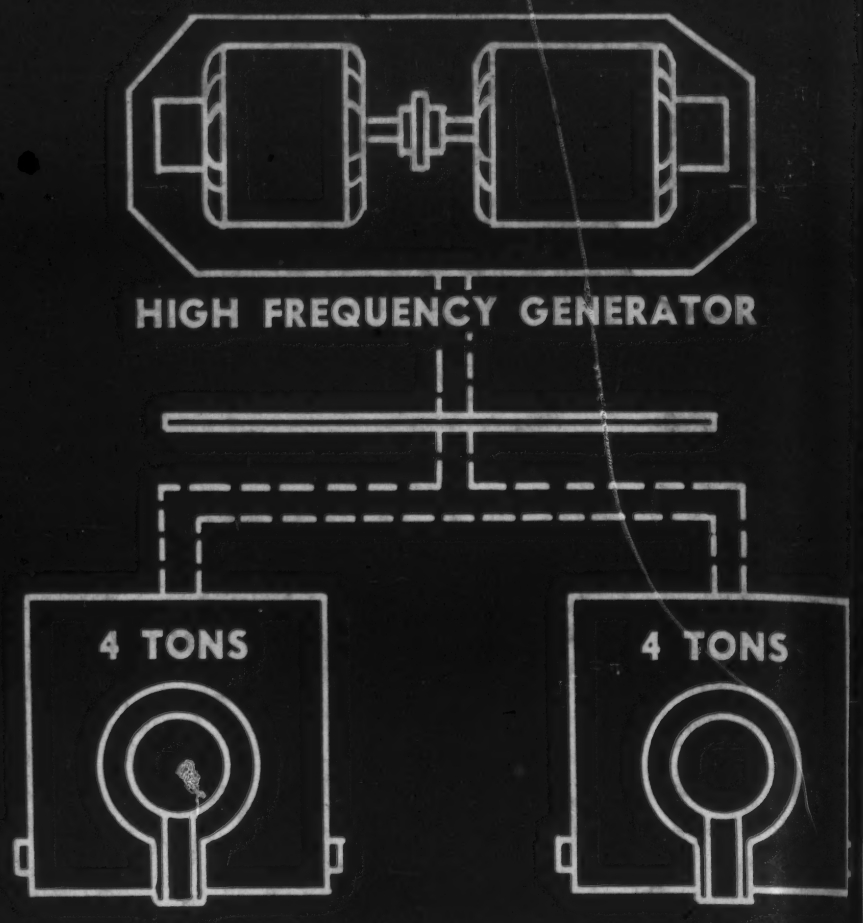
REG. U. S. PAT. OFF.

MANUFACTURERS OF GRINDING WHEELS, COATED ABRASIVES, SUPER REFRACTORIES, HEATING ELEMENTS

District Sales Branches: Chicago, Philadelphia, Detroit, Cleveland, Boston, Pittsburgh. Distributors: McConnell Sales and Engineering Corporation, Birmingham, Ala.; Christy Firebrick Company, St. Louis, Mo.; Harrison & Company, Salt Lake City, Utah; Pacific Abrasive Supply Company, Los Angeles, San Francisco, Calif.; Denver Fire Clay Company, El Paso, Texas; Smith-Sharpe Company, Minneapolis, Minn.

(Carborundum is a registered trade-mark of and indicates manufacture by The Carborundum Company)

44 TONS
OF ALLOY STEEL IN
24 HOURS
!



One high frequency generator and two 4-ton Ajax-Northrup Furnaces can melt and pour 11 heats or 44 tons of alloy steel in 24 hours.

Exact duplicate analyses, practically no loss of elements, automatic stirring, no contamination from electrodes or gases and long lining life are some of the outstanding advantages.

You can make partial melts, or substitute smaller furnaces to meet future requirements, or convert completely to heating at any time for a fraction of the original cost.

LABORATORY AND PILOT PLANTS. Most of our modern alloys were first melted in test samples of a few ounces. Pilot plant outfits melting 50 pounds frequently pave the way for large quantity production. Standard equipments range from simple 3 kw converters for one ounce melts to tube converters up to 60 kw and high frequency motor generators up to 1200 kw. Frequencies range from 1,000 to 1,000,000.

THE "KNOW HOW" OF HIGH FREQUENCY
The pioneer development of equipment for High Frequency melting and heating, and the subsequent application to hundreds of widely different jobs has produced a wealth of "know-how" which is not available from any other source.

If you want to know how you can speed up your war operations and at the same time provide for quick peace time conversion, get in touch with us.

AJAX HIGH FREQUENCY FURNACES

NORTHRUP AJAX ELECTROTHERMIC CORPORATION, AJAX PARK, TRENTON, N.J.

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AJAX ELECTRIC FURNACE CORPORATION. *Ajax-Wyatt Induction Furnaces for melting.*
AJAX ELECTRIC CO., INC. *Ajax-Hultgren Salt Bath Furnace and Resistance Type Electric Furnaces.*
AJAX ENGINEERING CORPORATION. *Aluminum Melting Furnaces.*